See Mars at Its Best This Winter

ASTRONOMY®

January 1995 U.S. $3.50
U.K. £1.95
Can. $4.95

Do Double Asteroids Roam the Solar System?

ICD 08070

BIG SCOPE OBSERVING!

The Sea of Serenity
Moon Observer's Notebook

- Take a Journey to the Heart of the Sun
- Explore Jupiter's Moon Io in Stereo

MEADE
12" LX200
10" LX200
8" LX200
MEADE LX200 EMC
Meade

Supplied complete per catalog specifications**:

8" LX200 Schmidt-Cassegrain	**$2495.**
10" LX200 Schmidt-Cassegrain	**$2895.**
12" LX200 Schmidt-Cassegrain	**$3995.**

Packing & shipping in 48 states: 8"—$105; 10"—$145; 12"—$215.

- **All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

- For dealer or catalog information see the **Meade Starfinder Reflecting Telescope** ad in this issue.

LX200

SCHMIDT-CASSEGRAINS

Now with *one arc-minute* pointing accuracy and 64,350-object onboard database as *standard-equipment!*

Meade 8", 10", and 12" LX200 models with standard-equipment High-Precision Pointing™ software now automatically GO TO any input RA and Dec, or to any object in the 64,350-object database, to a pointing precision within one arc-minute!

New Meade Version 3.30 software and high-resolution encoders, used in conjunction with the unique Meade SYNC command, now yield the most precise automatic slewing ever offered in a commercial telescope, an observatory-level of precision and *more than 5 times the precision obtainable with any competing computer-controlled telescope.* Data entry through the telescope's keypad hand controller may be made either from the onboard 64,350-object library database *(see description at right)* or by inputting the desired object's RA and Dec.

Such precise object-acquisition, selectable during either altazimuth or equatorial operation of the LX200, has numerous important implications for the serious observer:

HIGH
PRECISION
HP
POINTING

LX200's with High-Precision Pointing have the HP logo-plate affixed to the telescope's drive base.

☐ Use the GO TO command to *find and center an object in the field of a 4mm eyepiece.*

☐ With other telescopes, acquiring even bright objects on the chip of a CCD imager is generally a chore at best, searching and slewing by trial-and-error until at last the object is positioned on the chip. The LX200's High-Precision Pointing places *every* object on *every* CCD chip *every* time.

☐ Suppose you wish to CCD-image a supernova in an 18th magnitude galaxy—a galaxy invisible *except* through the process of CCD imaging. With Meade High-Precision Pointing, the galaxy can be placed on the chip of every commercially-available CCD unit.

☐ Photographing or imaging faint objects such as the planet Pluto, or comets and asteroids near the photographic limit of the telescope, and plotting the motion of these objects night-to-night, now becomes practical, since the photograph or image may be taken *without the observer ever having seen the object visually,* but knowing that the LX200 will place the object precisely in the telescopic field.

All Meade LX200 models now include a 64,350-object onboard database as standard equipment.

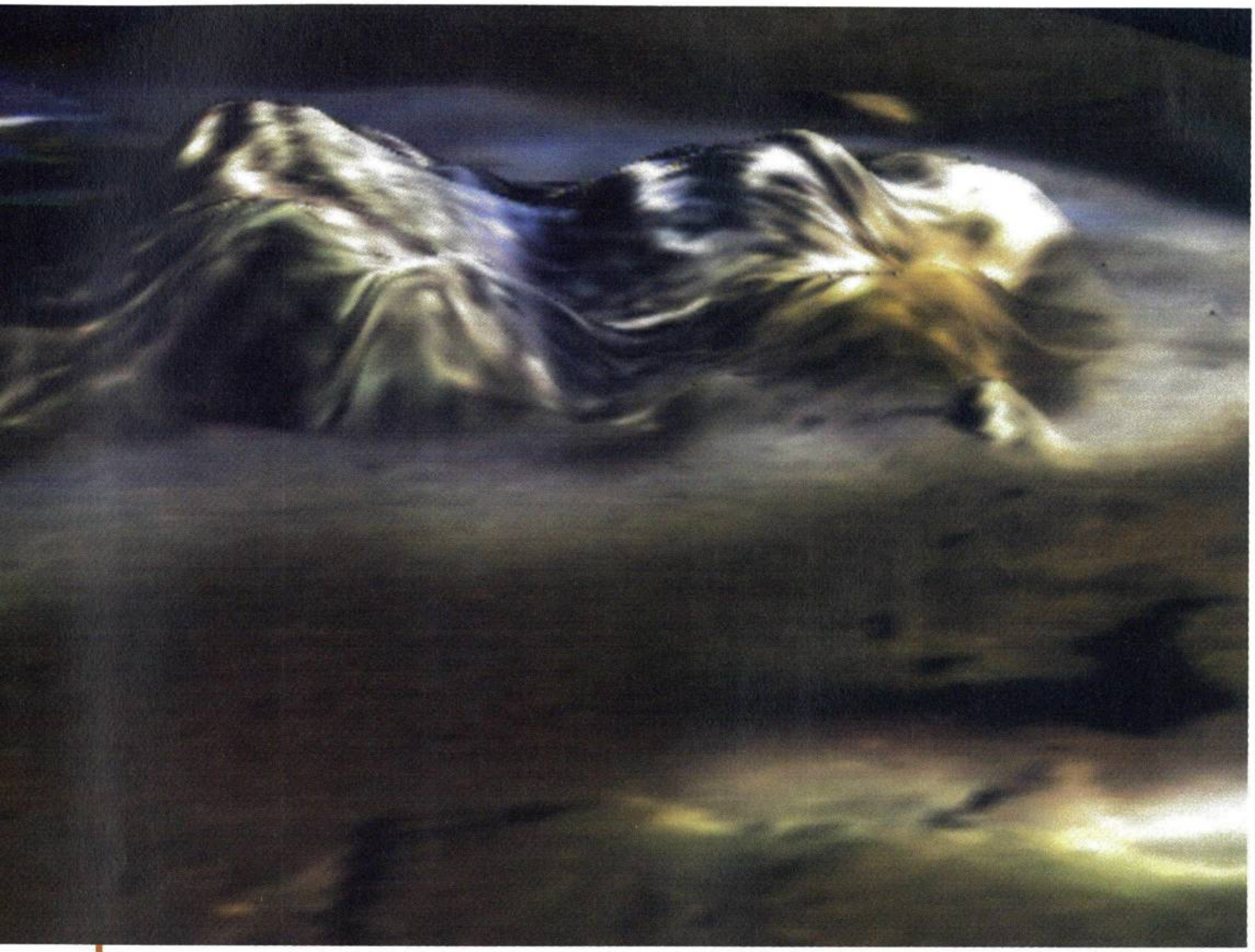
Imagine having 64,350 celestial objects at the tip of your finger: 64,350 objects that you can actuate and center in the telescopic field just by entering and pressing GO TO on the hand controller. **More than 6 times the size of object libraries included with competing telescopes,** the Meade 64,350-object library includes an incredible array of phenomena—virtually a lifetime of deep-space study, even for the advanced observer:

12,921	galaxies from the Uppsala General Catalog; the complete UGC catalog.
7,840	objects from the New General Catalog; the complete NGC catalog.
5,386	objects from the Index Catalog; the complete IC catalog.
21,815	variable stars; the complete listing from the General Catalog of Variable Stars.
15,928	stars from the Smithsonian Astrophysical Observatory (SAO) catalog of stars brighter than 7th magnitude.
351	alignment stars for the LX200 telescope.
110	Messier objects; the complete listing.
8	major planets from Mercury to Pluto.
64,359	objects, total

SPECIFICATIONS: 8", 10", and 12" LX200's—Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel display on the drive base; manual and electric slow-motion controls on both axes; keypad handheld controller with digital readout display, permanently programmable Smart Drive™, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,350-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC (for field operation from any 12v. auto cigarette lighter plug, use the Meade #1812 Electronic DC Adapter, a 4-oz. unit available optionally); 8 x 50mm viewfinder with crosshairs; 1.25" diagonal prism (8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (8", 10") or giant field tripod (12"); foam-fitted carrying case; complete operating instructions.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
16542 Millikan Avenue, Irvine, Calif. 92714 ☐ (714) 756-2291
FAX: (714) 756-1450
© 1994

ASTRONOMY®
January 1995
Vol. 23, No. 1



NASA/LPI processed by Paul Schenk

46 The Mountains of Io

30 Two by Two They Came
Intriguing double craters, radar images of nearby asteroids, and the discovery of a moon circling Ida all point to a solar system teeming with double asteroids. By Dan Durda.

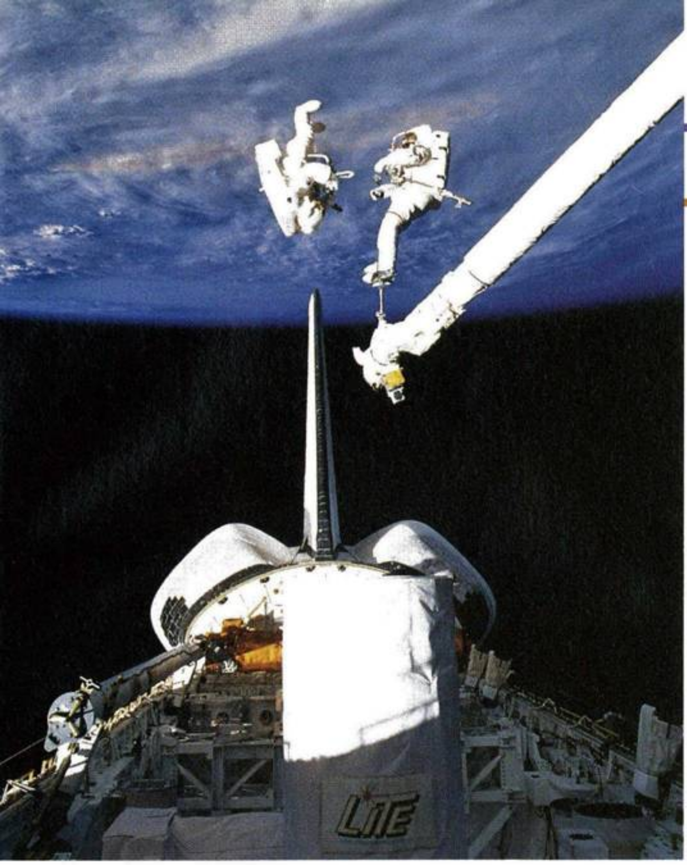
38 Journey to the Heart of the Sun
Travel with a photon from the Sun's core to its surface and discover what forces rule our star. By David H. Hathaway.

46 The Mountains of Io
Fifteen-year-old Voyager photos meet modern computer techniques to bring a fresh look at Jupiter's volcanically active moon. By Paul M. Schenk.

54 Sky Almanac
Turn your eye, and a telescope, to the sky to see Saturn dominating the evening sky and Venus and Jupiter shining brilliantly before dawn. By Deborah Byrd and Jeff Kanipe.

ON THE COVER

THE HORSEHEAD ranks as one of the more difficult nebulae to spot in backyard telescopes, but a 25-inch behemoth easily brings it into view. For more on observing through a big scope, see page 66. © 1984 Anglo-Australian Telescope Board .



NASA

20 AstroNews

72 Discover the Red Planet

Don Parker

James Boyd

38 Journey to the Heart of the Sun

Lick Observatory

76 Sailing the Sea of Serenity

66 Big Scope Observing

A 25-inch telescope captures faint targets deep in space and reveals incredible detail in bright objects. By David Higgins.

72 Discover the Red Planet

Unpack your scope and grab this guide to observe our celestial neighbor this winter. By Murray Paulson.

76 Sailing the Sea of Serenity

Craters young and old, distinct rilles and scarps, and towering mountains ringing the shore offer a smorgasbord of visual delights for backyard observers of this lunar sea. By Robert Burnham.

80 Build a 10-Inch PortaScope

It's big, it's portable, and it can be yours. Here's how to build a deep-sky observer's dream scope. By David Bruning.

DEPARTMENTS

6 Behind the Scenes
- Build Your Own Spaceship

6 Letters
- Return to the Moon?

16 AstroForum
- NASA's Needed Vision

20 AstroNews
- Hubble Finds Hidden Quasar
- Shuttle Astronauts Float Free
- A Fall into the Sun
- Hot, Luminous, with Strong Winds
- Gamma-Ray Flashes in Earth's Atmosphere
- Meteorite Crater Under Chesapeake Bay?
- Fewer Novae in the Galaxy
- United States, Russia Consider Pluto Mission

26 Amateur News
- A Midwest Gateway to the Stars
- Astronomical League Spotlights Young Astronomers

90 New Products
- Improved CG-11 Telescope Package
- Long Eye-relief, Waterproof Binoculars
- 1995 Lunar Phase Calendar

94 Astronomy Books
- Apollo 13: Terror and Triumph

96 AstroBytes
- Window on the Universe

98 Meetings and Events
- January – March

104 Resources & Photofacts

108 Advertiser Index

109 Reader Reports
- Comets, We've Got Comets . . .

BEHIND THE SCENES

Build Your Own Spaceship

Winter skies may be the year's brightest and best, but for many of us they're often cloudy. This makes the winter months a great time for indoor astronomy projects. In this issue we begin the first of a two-part series by Associate Editor Dave Bruning on building the PortaScope, a 10-inch Newtonian reflector on a Dobsonian mounting. It's an excellent telescope for the serious beginner.

Why build a scope when the market's overflowing with them? The reason's simple: You build a telescope because the market doesn't have exactly the instrument you want. Another good reason is that you just like the idea of crafting your own optical spaceship. With this in mind, Dave (that's him below) designed the PortaScope to be flexible. It scales down to an 8-incher for those who want something more portable, and it offers some latitude in the size of its secondary mirror and focuser.

ASTRONOMY: Jim Forbes

Above all, it's easy to build. Telescope making in the good ol' days was daunting. You ordered mirror blanks; you collected multitudinous grades of grit — and then you walked round and round the workbench, pushing the glass back and forth and back and forth, under a kind of discipline almost monastic in severity. And that was just to make the main mirror, never mind the mounting.

The PortaScope sets you free from all that. It uses manufactured components for the optics and other key parts. The necessary skills are limited to cutting up plywood, drilling holes, and gluing joints. Once you have the components, this spaceship is ready to launch in about three weekends of work. (NASA should have it so easy.)

ASTRONOMY launches a different kind of spaceship this month as well. If you haven't done so already, take a look at the center of the magazine. We redesigned Sky Almanac to make the Star Dome sky map and the Path of the Planets ecliptic chart easier to use. They now sit back-to-back on a fold-out page in the center of the magazine, and they're printed on slightly heavier paper stock. We also brightened the department's look and gave the highlighted sky events a mini table of contents to make them easier to find.

We also moved the popular Reader Reports department to just inside the back cover to give it geater visibility. Every week Associate Editor Dave Eicher receives dozens of photos, sketches, and written reports on observations made by you, the readers. Eyeing the deluge, we figured that such a high-interest department ought to go in a more visible place. We also thought you'd like seeing the Best Astrophoto of the Month displayed a little more prominently, so we put it as a splendid finish for Reader Reports and the magazine itself. We hope you like the changes.

Sincerely,

Robert Burnham
Editor

LETTERS

Return to the Moon?

Former astronaut Buzz Aldrin and members of the National Space Society have begun an initiative that will restore a sense of direction to international space programs: a return to the Moon. The Moon is the best space station we could hope to have. It is long past time for us to return and use the incredibly fortuitous (and rare) resource that providence has given us.

Along with the NSS, I want to urge astronomy and space enthusiasts everywhere to support the permanent Return to the Moon program as the central objective of all spacefaring nations and private groups between now and 2005. Like the opening and settlement of the American frontier, the settlement of the Moon will yield untold benefits such that our descendants will wonder why we waited so long. — *Ivan Dryer, West Hills, California*

Glued to the Moon

Thanks for broadly commemorating the Apollo 11 25th anniversary (July 1994). I can really relate to Ian Broadbent's memories and emotions of the period, though I was only nine years old in July '69. Just like Ian, I spent all night long glued to the television set. Andrew Chaikin's article was great, and his book will definitely find a place on my bookshelf very soon. Thanks also to David Bruning and to Graham Ryder for their "lunarologic" additions. — *Robert Gieseler, Göttingen, Germany*

I can't believe Ian Broadbent's cynical remarks regarding the first Moon landing (July 1994). He stated that "viewers probably protested when newscasters interrupted *I Love Lucy* to provide an update on the astronaut's extravehicular activity." Where was he 25 years ago? The entire world sat glued to the television to watch the lunar landing! I cannot accept

(continued on page 14)

ASTRONOMY®

Robert Burnham Editor
Rhoda Sherwood Managing Editor
David J. Eicher Associate Editor
David H. Bruning Associate Editor
John Shibley Associate Editor
Richard Talcott Assistant Editor
Tracy Staedter Editorial Assistant
Julie Sherwin Editorial Secretary

Thomas L. Hunt Art Director
Gary Kachar Graphic Designer

U.S. and International Newsstand Distribution
I.C.D., The Hearst Corp., New York, NY 10019

Walter J. Mundschau President
Russell G. Larson Publisher
James John Marsala Corporate Art Director

Daniel R. Lance Vice President, Sales & Marketing
Kimberly A. Bennett Advertising Sales Manager
Debbi A. Simon Advertising Sales Representative
Tracy Lando Advertising Services Representative
Advertising Department (800) 558-1544

Canadian Newsstand Distribution
Telemedia Dist., Toronto, Ontario M4S 3B3

ASTRONOMY is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Editorial phone: (414) 796-8776; advertising: (800) 558-1544; customer service: (800) 446-5489; subscriptions: (800) 533-6644 7 days a week, 24 hours a day; fax (414) 796-0126. Copyright © 1995 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second-class postage paid at Waukesha, WI, and additional mailing offices. Allow 6 to 8 weeks for new subscriptions and address changes. Subscription price: 1 year $27. Canadian and foreign: 1 year $38, GST (#R122713209) included; please remit in U.S. funds. Not responsible for unsolicited materials. POSTMASTER: Send address changes to Astronomy, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Canadian second-class postal permit no. 545775. Printed in the U.S.A.

The Audit Bureau

MEADE

EYEPIECES AND ACCESSORIES

Series 4000™ Super Plössls

Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types for 1994, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers–a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm each:	**$87.95**	(3.45)
32mm (52°); **40mm** (44°) each:	**109.95**	(3.79)
56mm (52°; 2")	**229.95**	(5.48)

Series 4000™ f/6.3 Focal Reducer/ Field Flattener

f/6.3 FOCAL REDUCER/FIELD

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5° at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture.

$129.95 (3.60)

Series 4000™ Super Wide Angle

For exquisite wide-angle images at low-to-medium powers, ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8, 18, and 24.5mm are superb complements to the #140 Barlow.

Super Wide Angle (SWA; 6-elements; 1.25"; 67°)–**13.8mm: $159.95** (3.49); **18mm: 169.95** (3.69); **24.5mm: 199.95** (3.89); **32mm** (2"): **279.95** (4.78); **40mm** (2"): **339.95** (5.48)

Series 4000™ Ultra Wide Angle

The ultimate eyepieces; extreme image sharpness over an amazing 84° field.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)– **4.7mm: $179.95** (3.29); **6.7mm: 219.95** (3.29); **8.8mm** (1.25"/2"): **269.95** (4.78); **14mm** (1.25"/2"): **329.95** (5.48)

Series 4000™ #140 2x Apochromatic Barlow Lens

The most advanced Barlow Lens available for commercial telescopes; includes 3-element, air-spaced optics, multi-coated. Unmatched in image resolution, contrast and color correction. Accepts 1.25" eyepieces. Lens dia. 28mm; clear aperture 26mm.

$79.95 (3.29)

SALE!

Series 3000 Plössls Save up to 30%!

Now you can buy Meade *multi-coated* Series 3000 Plössl Eyepieces—the finest moderately-priced eyepieces ever manufactured—at never-before prices!

See complete eyepiece description elsewhere on this page.

Buy one or buy a dozen!
No minimum, no maximum!

Series 3000 Plössl 5, 6.7, 9.5, 16, or 25mm:

each **$39.95** (3.45)

(regularly $46.95 to $57.95)

Series 3000 Plössl 40mm:

each **$69.95** (3.79)

(regularly $79.95)

This special offer is valid between November 20, 1994 and January 31, 1995, at participating Meade dealers in the U.S.A. and is subject to eyepiece availability.

Series 3000™ Plössls

The very latest in eyepieces from Meade optical designers, new Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Available in a wide range of focal lengths from 5mm through 25mm. All five eyepieces are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. Manufactured exclusively for Meade Instruments by one of Japan's leading lensmakers, Series 3000 Plössls produce excellent results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$57.95** (3.45) **Any 2: $52.95** each; **Any 3: $48.95** each; **Any 4 or 5: $46.95** each.

Series 3000™ Plössl 40mm

A perfect complement to the Series 3000 Plössls at left, this all-new Plössl 40mm produces spectacular low-power, wide-field results with any telescope. Includes classical 4-element Plössl optics, multi-coated. Barrel dia. 1.25"; threaded for filters. Apparent field: 44°.

$79.95 (3.79)

Series 4000 Photo-Visual Color Filters (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each	**$14.95**	(2.29)
Moon Filter #ND96–Reduces brightness by 87%.	**16.95**	(2.29)
Set #1–4 filters: #12, #23A, #58, #80A	**54.95**	(2.98)
Set #2–4 filters: #11, #25A, #47, #82A	**54.95**	(2.98)
Set #3–4 filters: #8, #21, #38A, #56	**54.95**	(2.98)
Sets #1 & #2–8 filters	**99.95**	(3.45)
Sets #1, #2, & #3–12 filters	**144.95**	(3.79)

#911B
#910B
#908B
#911N
#910N
#908N

Series 4000 Nebular Filters—Premium multi-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high-contrast observing of faint nebulae.

#908B–Threads into 1.25" eyepieces, 26mm dia.	**79.95**	(2.98)
#910B–Threads into 2" eyepieces, 44mm dia.	**119.95**	(3.29)
#911B–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**99.95**	(3.29)
#908N–Threads into 1.25" eyepieces, 26mm dia.	**89.95**	(2.98)
#910N–Threads into 2" eyepieces, 44mm dia.	**129.95**	(3.29)
#911N–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**119.95**	(3.29)

World's Most Advanced Illuminated Reticle Eyepiece

Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. **Internal batteries included.** Multi-coated optics. Bullseye reticle. 1.25"

$149.95 (3.45)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (3.45)

MA 12mm Illuminated Reticle Eyepiece

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Wireless red LED illuminator and variable brightness control. **Batteries included.**

$99.95 (3.45)

MA 12mm—Same as above but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator.

$79.95 (3.45)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter. **$99.95** (3.79)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

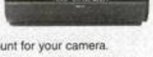
.965": $27.95 (2.98) **1.25": $29.95** (2.98)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (2.98)

Tele-Extenders



For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to any eyepiece-holder. Use with T-mount for your camera.

Basic Tele-Extender: *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos.

$29.95 (2.98)

Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece.

$39.95 (2.98)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera.

$26.95 (2.98)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (3.45)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25"

$59.95 (3.45)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.

$47.95 (3.45)

Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, these 3-element Modified Achromatic eyepieces give sharp, faithful, well-corrected images of the moon, planets, and deep-space at an economical price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

each: **$37.95** (2.98)

HOW TO ORDER

- Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.
- Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.
- Meade accessories may be ordered from any Meade Advanced Products Dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE CO., Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Info/IL: 312-332-2000.

Canada:
KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

© 1994

MEADE
STARFINDER™ DOBSONIANS

Now you can buy a Dobsonian telescope with quality Meade® optics and components—at a fraction of the price you'd expect to pay.

And, extended through December 31, 1994, receive a $125 Accessory Package for only $29.95!

MEADE
MEADE
MEADE
MEADE
STARFINDER
MEADE
STARFINDER
MEADE
STARFINDER
MEADE

10" f/4.5
$565.

12.5" f/4.8
$765.

8" f/6
$395.

Shown with optional #637 6 x 30mm or #545 8 x 50mm Viewfinders

6" f/8
$295.

SPECIAL ACCESSORY OFFER!

Through December 31, 1994, at the time you order any Starfinder 6", 8" 10", 12.5", or 16" Dobsonian Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces *and* the Meade #637 6 x 30mm coated achromatic viewfinder for a *total* of only $29.95! Purchased separately, the 2 additional eyepieces and viewfinder sell for $125.85!** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces, with #637 6 x 30mm viewfinder.)*

MEADE
STARFINDER
MEADE

Starfinder Dobsonian 16

16" f/4.5
$1195.

See the Meade General Catalog for details.

Includes giant #682 focuser; shown with optional 8 x 50mm viewfinder.

Compare Meade Starfinders *feature-for-feature* with other similarly priced Dobsonians!

- **Primary and Secondary Mirrors of Low-Expansion Pyrex® glass!** Unlike the plate-glass optics of other Dobsonians that can become thermally unstable (especially in larger apertures), Meade Dobsonians include the *exact same* professional-quality Grade-A, fine-annealed Pyrex® optical systems used on Meade Starfinder Equatorial Reflectors. Optics that meet the theoretical limits of resolution for their apertures.
- **Precision Rack-and-Pinion Focuser!** An industry-standard full-size rack-and-pinion system with 2.6" of focus travel.
- **Fully-Adjustable 4-vane Secondary Mirror Systems!** *Rigid 4-vane systems* that permit precision alignment of the secondary mirror to the primary mirror.
- **Rigid, Durable, Beautiful Dobsonian Mountings!** Mountings that provide extremely smooth motions of the telescope in both altitude and azimuth. Both telescope axes ride on zero-backlash Teflon/Nylon bearings, facilitating the location and tracking of celestial objects anywhere in the sky. Each mount is manufactured of cabinet-quality materials and designed for a lifetime of use. Handles are provided for easy portability.
- **Optical Tubes:** Starfinder Dobsonians include the same strong, spiral-wound optical tubes used on Starfinder Equatorials *(facing page)*. All telescopes include a multi-coated MA25mm eyepiece as standard equipment. Each tube is factory pre-drilled for the optional 6 x 30mm or 8 x 50mm viewfinder.
- **Performance!** A Meade Starfinder Dobsonian or Equatorial Telescope opens up the skies to an extremely wide range of serious visual observing: all 110 Messier objects, thousands of NGC objects–nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning, high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography and even for limited deep-space astrophotography.
- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$39; 8"–$49; 10"–$69; 12.5"–$79. 16"–$45 packing, shipped truck freight collect.
- **To Order:** Contact one of the authorized mail-order dealers on the facing page.

MEADE

STARFINDER™ EQUATORIALS

***Complete* 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization… from $599.95!**

6" f/8
$599.95

8" f/6
$699.95

10" f/4.5
$799.95

- **Electric Motor Drive** (115v/60Hz) with 6 ft power cord: permits **fully automatic** tracking of celestial objects; plugs into any standard outlet.
- **Standard Accessories and Components:** Precision Rack-and-Pinion Focuser (1.25") with full 2.6" travel; coated achromatic #637 6 x 30mm Viewfinder with crosshair eyepiece and 7° field; multi-coated MA25mm (1.25") eyepiece, threaded for filters; strong, durable, spiral-wound optical tube with attractive white finish.
- **Optional Accessories:** See the Meade accessories ad in this issue. Additional systems, including #55 Manual Declination Control, #43 Drive Corrector, and #47M Dual-Axis Drive Corrector, are described in the Meade General Catalog.

SPECIAL ACCESSORY OFFER! Through December 31, 1994, at the time you order any Starfinder 6", 8", 10", or 16" Equatorial Telescope, you can buy **two additional Meade multi-coated Modified Achromatic MA9mm and 12mm eyepieces for a *total* of only $19.95! Purchased separately, the two additional eyepieces sell for $75.90.** *(Shown in photo: MA9mm, MA12mm, and standard-equipment MA25mm eyepieces.)*

- **Packing and UPS Shipping Charges:** to any address in the 48 states: 6"–$65; 8"–$75; 10"–$90. 16"–$55 packing, shipped truck freight collect.
- All prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.
- **All-new 1994-95 Meade General Catalog**–$3.00 postpaid–is available from any authorized Meade dealer or directly from Meade Instruments.
- For further information call Meade Instruments at 714-756-2291 or contact one of these authorized mail-order dealers:

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

CITY CAMERA, Dearborn, MI.
Orders: 800-359-5085; Info.: 313-846-3922.

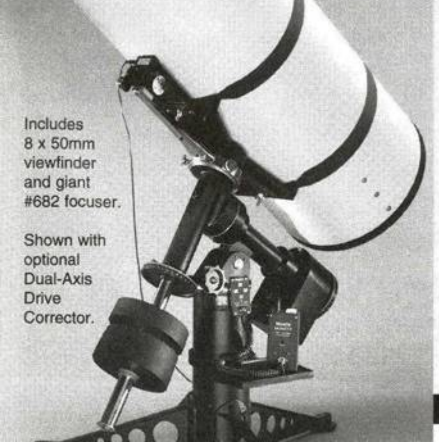
FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

Canada:
KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

Starfinder Equatorial 16



16" f/4.5
$2495.

See the Meade General Catalog for details.

Includes 8 x 50mm viewfinder and giant #682 focuser.

Shown with optional Dual-Axis Drive Corrector.

Standard equipment on 6", 8", and 10" models includes:

- **Superb Optical System:** Includes hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of low-expansion, Grade A, fine-annealed Pyrex® glass.
- **Precision Equatorial Mount:** Manufactured of machined aluminum to tolerances of .001" or better, with 4"-dia. pier and die-cast tripod legs, for rock-solid support of the optical tube. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint objects directly from their catalogued coordinates.

ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

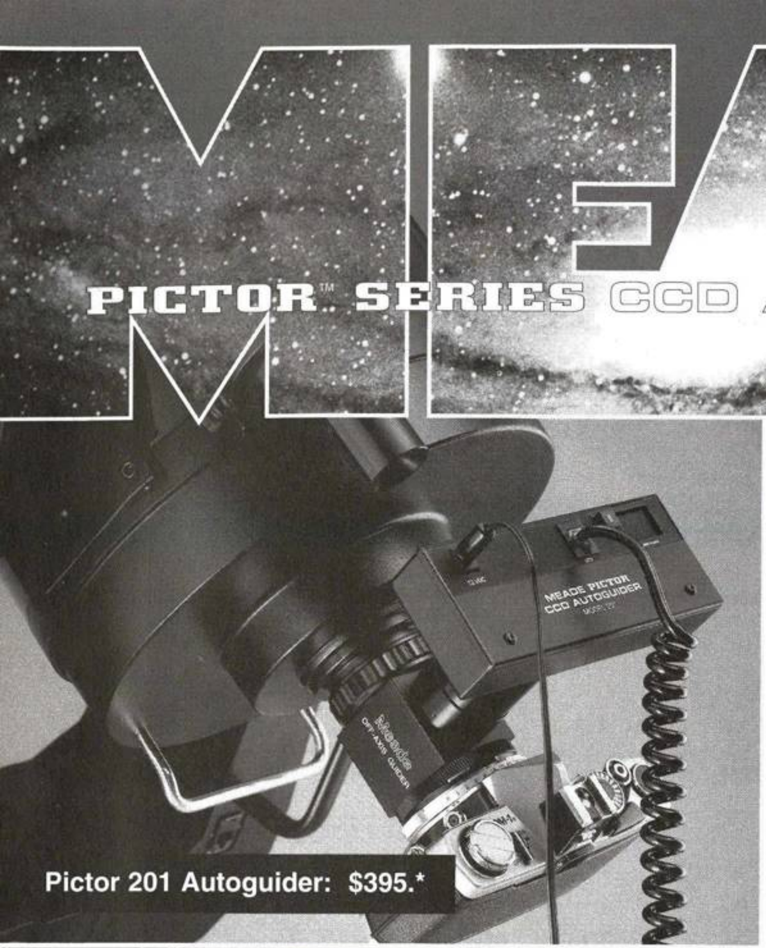
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur

16542 Millikan Avenue, Irvine, Calif. 92714 ☐ (714) 756-2291
FAX: (714) 756-1450

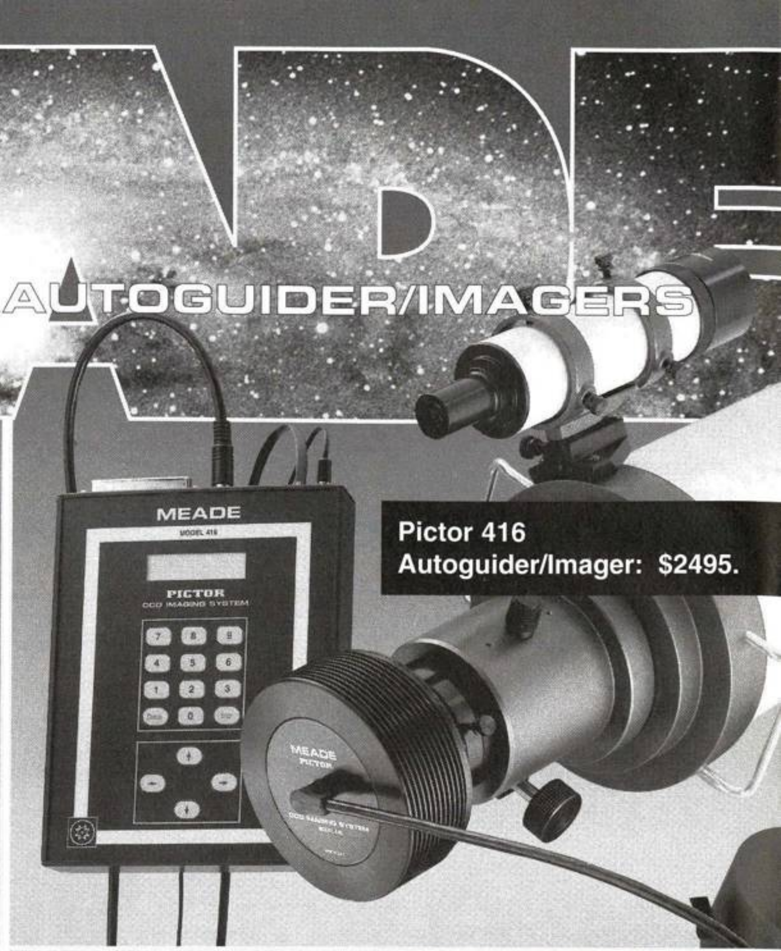
© 1994

MEADE

PICTOR™ SERIES CCD AUTOGUIDER/IMAGERS


MEADE PICTOR
CCD AUTOGUIDER
Meade
OFF-AXIS GUIDER

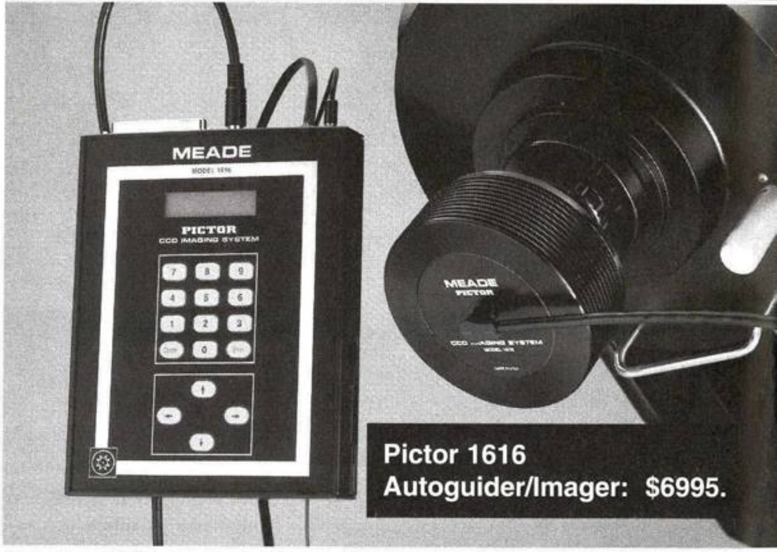
Pictor 201 Autoguider: $395.*


MEADE
MODEL 416
PICTOR
CCD IMAGING SYSTEM
MEADE
PICTOR

Pictor 416 Autoguider/Imager: $2495.

MEADE PICTOR
CCD IMAGING SYSTEM

Pictor 208 Autoguider/Imager: $795.


MEADE
PICTOR
CCD IMAGING SYSTEM
MEADE
PICTOR

Pictor 1616 Autoguider/Imager: $6995.

MEADE PICTOR
CCD IMAGING SYSTEM

Pictor 216 Autoguider/Imager: $1195.

For the beginner, or for the most advanced observer, the *real* CCD revolution is here. There's a Meade® CCD system to fit your budget and your imaging requirements.

To obtain your copy of the all-new Meade 76-page 1994-95 General Catalog ($3.00 ppd.), see your authorized Meade Advanced Products Dealer or write directly to Meade Instruments.

*Plus packing and shipping; prices shown are suggested U.S.A. mail-order prices, not including any applicable sales taxes.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
16542 Millikan Avenue, Irvine, Calif. 92714
(714) 756-2291 ☐ FAX: (714) 756-1450

© 1994

MEADE
THE LEGEND CONTINUES...
MEADE LX200
MEADE LX200 EMC

16" LX200

Professional instrumentation for the demanding school, college, or university research program—or as the ultimate personal telescope for the advanced amateur.

Professional-grade 16" f/10 optical system meets or exceeds advanced requirements; includes BK7 correcting plate for high UV transmission and EMC super multi-coatings. ■ **Massive one-piece fork mount** permits substantial auxiliary equipment to be piggybacked with rock-solid stability. ■ **Large 11" worm gears** on both axes, with factory-programmed Smart Drive™; periodic error less than 5 arc seconds. ■ **Automatic GO TO capability** to any object in the onboard 64,350-object database or to any input R.A. and Dec. ■ **High-Precision Pointing™** to within one arc-minute in the GO TO mode. ■ **DC servo drive systems** with integrated encoders and planetary gearboxes; encoder resolution: 0.13 arc secs. ■ **Six pushbutton-controlled drive-speed rates,** from photo-guide to fast-slew on both axes, simultaneously. ■ **Micro-processor controlled sidereal-rate tracking** in AZ or EQ modes with quartz accuracy. ■ **Home-Pulse Acquisition** permitting remote alignment and operation through a modem link to the telescope's RS-232 interface. ■ **Control panel connectors** for optional systems including CCD autoguiders and imagers, electric focuser, and the Meade **#1222 Field De-rotater** for long-exposure astrophotography in the AZ mode. ■ Available with **supergiant transportable field tripod** (2-person field set-up in less than 10 minutes); **permanent altazimuth pier** (permitting the entire instrument to be housed in a 2-meter dome); or **permanent equatorial pier** (in cases where piggybacked astrocameras do not permit field de-rotation).

The Meade 16" LX200 is in continuous production at the Meade Irvine, Calif. factory. **Delivery time:** 4 to 12 weeks, depending on order status. **Price:** $14,950, complete with supergiant field tripod, plus $385 packing and shipping in the 48 states; prices slightly higher with permanent altazimuth or equatorial pier.

For your copy of the all-new **1994-95 Meade General Catalog** ($3.00), write Meade Instruments or contact your authorized Meade Advanced Products Dealer.

ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur

16542 Millikan Avenue, Irvine, Calif. 92714 ☐ (714) 756-2291
FAX: (714) 756-1450

© 1994

MEADE
THE LARGEST-SELLING SERIOUS TELESCOPES IN THE WORLD

Meade Instruments is pleased to recommend the authorized Meade dealers on these pages for your telescope-buying requirements. Whether you're looking for a quality entry-level telescope at under-$200, a fully equipped professional instrument at over-$5000, or one of more than 2 dozen models in between, there's a Meade telescope that's right for your budget and applications.

NATIONAL

Meade Telescopes and Accessories are available at
THE NATURE COMPANY
Over 100 stores nationwide.
Call **1-800-367-6178**

ARIZONA

Quality Meade telescopes and accessories
Mr. Telescope
2053 E. Camelback Rd.
Phoenix, AZ 85016
602-955-5521

ARIZONA

The complete line of Meade telescopes
Stellar-Vision & Astronomy Shop
1835 S. Alvernon #206
Tucson, AZ 85711
602-571-0877

ARIZONA

SEDONA TELESCOPE CENTER
Consult with amateur astronomers who know their product line.
Demo a Meade under dark AZ skies.
1650 W. Highway 89-A, Sedona, AZ 86336
602-282-4930 All AZ 800-281-4930

CALIFORNIA

Your Meade Specialist
Oceanside Photo & Telescope
1024 Mission Avenue
Oceanside, CA 92054
619-722-3348

CALIFORNIA

Claremont Camera & Video
If it's quality Meade telescopes you're looking for – We offer it all!
863 W. Foothill Blvd., Claremont, CA 91711
909-626-2219

CALIFORNIA

Central California's quality Meade dealer
Meadows Camera Shops
6506 Pacific Avenue
Stockton, CA 95207
209-477-9421

CALIFORNIA

WHAT IN THE WORLD
We will demo Meade products in our dark mountain skies!
28200 Hwy. 189, #E-210
Lake Arrowhead Village, CA 92352
909-337-5080

COLORADO

Mike's Camera, Inc.
Your source for the complete line of popular Meade telescopes.
2500 Pearl St., Boulder, CO 80302
1-800-443-1715

CONNECTICUT

Milford Camera Shop
If it's quality Meade telescopes and service you need – We offer it all!
9 River St., Milford, CT 06460
203-878-0156

FLORIDA

PHIL'S CAMERA SERVICE
South Florida's Largest Selection of Quality Optical Instruments.
11517 So. Dixie Hwy., Miami, FL 33156
305-238-7842

FLORIDA

COLONIAL PHOTO & HOBBY
Central Florida's headquarters for all your astronomical needs. We stock Meade.
634 No. Mills Ave., Orlando, FL 32803
1-800-841-1485

FLORIDA

Jim's Photo Shack, Inc.
Authorized Meade dealer. We know telescopes—call for expert advice.
4100 E. Bay Dr., Clearwater, FL 34624
813-536-9661

FLORIDA

Sarasota Camera Exchange & Video Center
Telescope specialists! We help you choose the right scope or accessory. Big stock of Meade!
1055 So. Tamiami Tr., Sarasota, FL 34236
813-366-7485

FLORIDA

WHAT A WORLD! 3 Locations...
Tampa—Tampa Bay Mall
813-875-9306
Clearwater—Countryside Mall
813-799-3663
Tallahassee—Governors Square Mall
904-671-4343

GEORGIA

Camera Bug Ltd.
Atlanta's Leading Telescope and Binocular Dealer. We Ship Practically Anywhere.
1799 Briarcliff Rd., Atlanta, GA 30306
404-873-4513

MICHIGAN

RIDER'S HOBBY SHOPS
Serving Michigan Since 1972
Telescopes, Spotting Scopes, Binoculars
Competitive Discount Prices
Call John at **616-349-2666** for expert advice and the store location nearest you.

NEW HAMPSHIRE

Largest Meade Display in N.E.
Trade-ins! No tax! Personal service!
RIVERS CAMERA SHOP
454 Central Ave., Dover, NH 03820
603-742-4888

NEW JERSEY

TUTHILL YOUR ASTRONOMICAL FRIEND

A full-line Meade dealer for 15 years!

11 Tanglewood Lane
Mountainside, NJ 07092
1-800-223-1063

NEW JERSEY

N.J.'s Largest Display of Meade Telescopes.

Dover Photo Supply

25 E. Blackwell St.
Dover, NJ 07801
201-366-0994

NEW MEXICO

PhotoSupply, Inc.

Stocking New Mexico's largest selection of Meade telescopes.

DeVargas Shopping Ctr., Santa Fe, NM 87501
505-982-2585

NEW YORK

Berger Bros. Camera & Video Exchange

Excellent Advice, Prices and Reputation For 50 Years

209 Broadway (Rte. 110), Amityville, NY 11701
1-800-262-4160

NEW YORK

We have specialized in selling telescopes for over 10 years! See us for expert advice!

Johnson's Camera

6565 Kinne Rd. at Erie, DeWitt, NY 13214
315-446-0290

NEW YORK

Tracy-Adams Photo Supplies, Inc.

Largest Selection of Telescopes and Accessories in Upstate NY.

4508 Commercial Dr., New Hartford, NY 13413
315-768-6008

NORTH CAROLINA

Your quality Meade dealer in North Carolina

CC Sales/ Camera Corner

Phone: **1-800-868-2462**
Fax: **910-222-8011**
2273 So. Church St., Burlington, NC 27215

NORTH CAROLINA

BALL PHOTO SUPPLY CO.

Your source for Meade products—sales, trade-ins, repairs.

Three Generations of Experience

85 Tunnel Rd., Innsbruck Mall, Asheville, NC 28805
Phone: **704-252-2443** Fax: **704-253-1457**

OHIO

PETE'S PHOTO WORLD

Competitive Prices! Great Service!
Telescope expert on staff. Ask for Craig.
Serving the tri-state: OH, KY, IN.

7731 Beechmont Ave., Cincinnati, OH 45255
1-800-736-7383

OKLAHOMA

EARTH HOME

Stocking Dealer for Meade Telescopes.

Penn Square Mall
Oklahoma City, OK 73118
405-840-9993

PENNSYLVANIA

The Camera Shop In Bryn Mawr

Suburban Philadelphia's
Photo & Optical Specialists

572 Lancaster Ave., Bryn Mawr, PA 19010
610-527-0300

PENNSYLVANIA

Specialists in telescopes! 13 stores—PA, NJ, DE—always friendly and knowledgeable.

CUTLER CAMERA

537 Easton Rd., Horsham, PA 19044
1-800-220-5727

SOUTH CAROLINA

Your Quality Meade Telescope Dealer for So. Carolina—10 Convenient Locations!

Jackson Camera & Video

Columbia: **803-776-7000**
Charleston: **803-766-2752**

SOUTH CAROLINA

The Audubon Shop & Gallery

Your Window to the Natural World.

245 King St., Charleston, SC 29401
1-800-453-BIRD

TEXAS

WEAVER SPORTING GOODS

*We are telescope specialists! Want the right product recommendation and info.—**see us!***

3515 West Vickery, Ft. Worth, TX 76107
817-731-0804

TEXAS

Land, Sea & Sky Unlimited

Complete sales and service of Meade telescopes. We are optical specialists.

3110 S. Shepherd Dr., Houston, TX 77098
713-529-3551

TEXAS

Analytical Scientific

If it's a quality Meade telescope you're looking for, call us.

11049 Bandera Rd.,
San Antonio, TX 78250
210-684-7373 • 800-701-STAR

VIRGINIA

Redlich Binocular & Optical

We offer the complete line of quality Meade telescopes.

711 West Broad St., Falls Church, VA 22046
703-241-4077

VIRGINIA

Your Meade Telescope Specialists in the Norfolk, Suffolk, Va. Bch., Areas.

Eagleton's

430 Boush St., Norfolk, VA 23510
804-622-1881 Hrs: 8-5 M-F, 9-12 Sat.

WASHINGTON

Meade Telescopes & Accessories

The Naturium

Northtown Mall, Spokane, WA
509-484-7014
Kitsap Mall, Silverdale, WA
206-698-3580

WISCONSIN

Wild Birds Unltd/Eagle Optics

*If it's quality Meade product you're looking for, **call us**! We're **specialists** in optics!*

716 So. Whitney Way, Madison, WI 53711
608-271-4751

CANADA

PERCEPTOR

Friendly Service, Expert Advice, Low Prices, Full Meade Line, Free Literature

Brownsville Jct. Plaza, Box 38, Suite 201
Schomberg, Ontario L0G 1T0
905-939-2313

CANADA

Efstonscience

We carry the full line of Meade products at competitive prices.

3350 Dufferin St., Toronto, Ont. M6A 3A4
Phone: **416-787-4581** Fax: **416-787-5140**

MULTIPLE STATES

RITZ CAMERA SUPERSTORES

Two Super Locations to Serve You

945 Bald Hill Rd., Warwick, RI 02886
401-823-0073
960 Federal Hwy., Pompano Bch., FL 33062
305-781-0555

The Observer's Handbook 1995

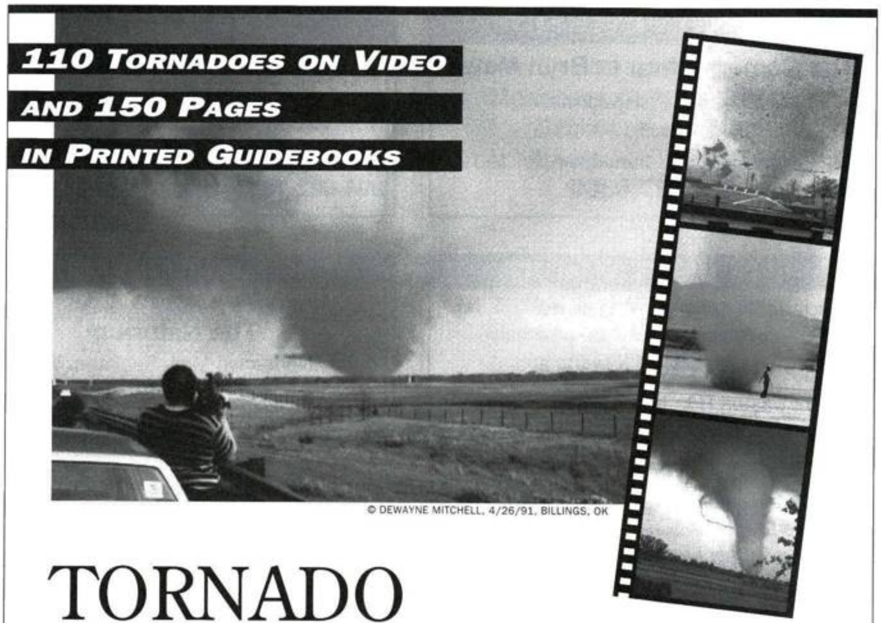
Essential information on current astronomical phenomena at your fingertips—no computer required!

- 87th year of publication—major revisions annually
- compact 240-page paperback format fits in pocket or eyepiece case
- detailed and authoritative data for observers worldwide
- sections on observing, optics, meteors, comets, deep-sky objects and much more
- 35 expert contributors, including: comet hunter David Levy, astronomy author Terence Dickinson, supernova hunter Rev. Robert Evans, and Dr. Brian Marsden of the IAU

To order the 1995 Observer's Handbook, send $15.89 U.S. (includes postage) to:

The Royal Astronomical Society of Canada, Dept. H
136 Dupont Street, Toronto, Ontario M5R 1V2, Canada

110 TORNADOES ON VIDEO AND 150 PAGES IN PRINTED GUIDEBOOKS



© DEWAYNE MITCHELL, 4/26/91, BILLINGS, OK

TORNADO VIDEO CLASSICS I & II
THE TORNADO VIDEO TEXTBOOK

TORNADO VIDEO CLASSICS I

is internationally acclaimed as the finest and most complete tornado video program in existence. It combines the 68 most famous and spectacular tornadoes with a dozen research experiments and a 3,600-word narration. You'll see merging tornadoes, tornado families, a cockpit view of rockets being fired at tornadoes, model tornadoes compared with close-ups from a helicopter, multiple vortex tornadoes, successful chases with portable Doppler radar and TOTO, telephone poles on rocket sleds to simulate tornado missiles, and more. Each scene is numbered on screen and keyed to the 50-page, 14,000-word printed guide.

Full color Gallery poster of an INCREDIBLE Tornado photo!

TORNADO VIDEO CLASSICS II

uses 42 new close-encounter tornadoes including an F-5 monster outside the living room window. A man is hit by lightning while filming a tornado, but doesn't stop until he is hit by debris from his own house. Visit the world of "Mr. Tornado," Professor T.T. Fujita, with spectacular tree-snapping, roof-flying footage in hurricanes and downbursts. The 100-page video guide is a treasury of severe storm information. It includes details on all scenes in the video and adds a 200-term glossary of severe storm and tornado spotter/chaser terminology.

Call or Write Today!

Tornado Video Classics I (2-hour video, 50-page guide)	$35
Tornado Video Classics II (2-hour video, 100-page guide)	$39
Both tapes and guides	$65
Gallery Poster (17x22 inches, a perfect gift)	$11

Prices include priority rate postage. Add $12 for overseas or PAL format. MC/Visa/AmEx accepted.

The Tornado Project, Box 302A St. Johnsbury, VT 05819 or call 802 748-2505

A

LETTERS

Broadbent's statement that "for many people the Apollo Moon flights marked only a brief pause in the monotony of life — hours of television coverage that seemingly amounted to nothing." It wasn't so, and it gives the younger generation the wrong impression. — *Nancy Martsch, Van Nuys, California*

Too Much CCD?

Recent articles and editorials about excesses in CCD coverage overlook one important consideration. While CCDs may not be used by the majority of readers at the present time, neither are many of the other techniques that enable us to read about our rapidly unfolding understanding of the wonders of the universe.

Creating a demand for amateur use of CCD technology hastens the day when we will all be able to purchase a battery-powered, full-color CCD image-enhancement system for our small scopes. Describing wonders that are beyond the personal reach of most of us, and better yet, outlining the means by which we may begin to observe some of them, are two of the many pleasures ASTRONOMY magazine offers readers. — *Jack Hobart, Los Angeles, California*

Astrophotography the Old Fashioned Way

The article "Snatching Beauty from the Deep Sky" (October 1994) contained a couple of inaccuracies. My mount is a Schaefer model AT-120, which is mounted on an aluminum tripod.

Also, I still do the "dirty work" of guiding. Although I do plan to purchase an autoguider, all the images in the article were guided by hand (times range from 25 to 120 minutes). Indeed, an autoguider is not a necessity for snatching beauty from the deep sky. It just makes it a lot easier. — *Martin C. Germano, Thousand Oaks, California*

Schröter's Canyon

I was reading my September issue when I came to page 45 and learned that Schröter's Valley on the Moon "extends for 160 km, measuring up to 11 km deep and 1 km wide." I thought, "Man, what a gully!" But then I got back to page 68 and there this valley had shrunk to its proper size of 160 km long and about 1 km deep. I greatly enjoy ASTRONOMY despite the occasional fault. — *Leland Shetler, Mountain Home, Idaho*

Another Comet Crack Up

I observed Comet Machholz 2 (1994o) from a site in the Superstition Mountains 40 miles east of Phoenix on

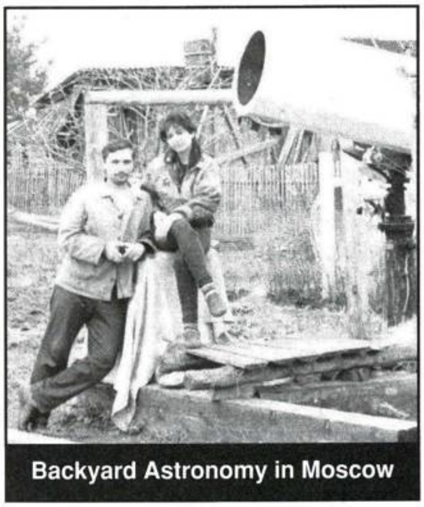
September 14, 1994. It was about 30° high in the eastern sky at the beginning of morning twilight. Like Comet Shoemaker-Levy 9, this object appears to be fragmenting.

Through my 8-inch f/3.8 RFT at 85x, I could see two of the comet's five pieces. The primary body is a typical 7th-magnitude comet, appearing 4' across with a slight central condensation. Accompanying the bright object, 30' to the north-northeast, was a very faint companion that I estimated to be glowing at 10th magnitude. It appeared 2' across and had no central condensation.

In my 17 years of viewing comets I can't remember another one with a companion (other than Shoemaker-Levy 9). It's an amazing coincidence that the two events were so closely spaced in time. — *Tom Polakis, Tempe, Arizona*

Hello from Moscow

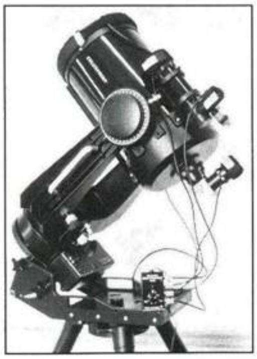
Greetings from the Sokolniky Park Astronomy Club in Moscow, Russia. Our group of 15 young amateurs takes pride in producing for ourselves Newtonian reflectors on Dobsonian mounts and using them to observe a wide variety of sky objects. We are also working on a Schmidt camera and a gravity-driven clock so that we might obtain pictures of the Moon and bright galaxies. We wish much success in observing the sky to amateur astronomers all around the world. — *Albert V. Garnelis, Moscow, Russia* ☐



Albert V. Garnelis

Backyard Astronomy in Moscow

ASTRONOMY welcomes feedback. Send your letters to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187, or on the Internet, use 72000.2704@CompuServe.com. Letters may be edited for length and clarity.



The Kendrick
Dew Remover System

A unique, high quality and temperature controlled heating system that REALLY WORKS.

We have heaters for telrads, eyepieces, finderscopes, guidescopes, secondary mirrors, main objectives up to C14s, binoculars and cameras.

For a free brochure and price list,
please send SAE to:

Jim Kendrick Studio
2775 Dundas Street West
Toronto, Ontario • Canada M6P 1Y4
Orders only: 1-800-393-5456
For technical information call:
416-762-7946
Fax: 416-767-4112

Attention Please:

S.B.I.G.

Proven 'state-of-the-art'
Reliable CCD*Technology*

•FULL-LINE DEALER•
ST-4, ST-4X, ST-5, ST-6,
ST-7, ST-8, TRI-COLOR

- **Exclusive Flip-Mirror, Guiding, & Filter Wheel Hardware**
- **Unique Fabulous Software**
- **Expert Tech Help &Timely Delivery**

Call Mon-Fri
9 to 5 Calif time. (800) 735-1352
or Write or Fax for Free
NEW! Brochure
from
Spectra
Astro • Systems
fax# 818-996-7698...24 hrs
6631 Wilbur Ave., Suite 30
Reseda, CA 91335

WHERE NEXT, COLUMBUS?

The Future of Space Exploration

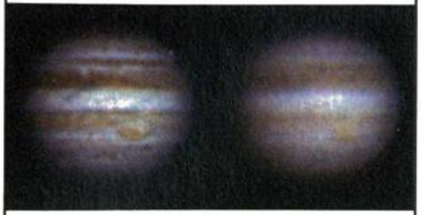
Edited by Valerie Neal

"**Stimulating, intellectually provocative**...richly literate....A feast of ideas that harvest the past, dissect the present, and surge to the future."
—Bill Pogue, Skylab Astronaut

Boasting an oversized format and more than fifty color illustrations, this engaging volume brings together a group of noted thinkers—including Stephen Jay Gould, Carl Sagan, Timothy Ferris, Robert L. Forward, and Stephen J. Pyne—who offer stimulating insights into the past and possible future of space exploration. $35.00, 231pp.

At bookstores everywhere. 1-800-451-7556
OXFORD UNIVERSITY PRESS

Stellar Products **AO-2 Adaptive Optics System**



AO-2 turned on | AO-2 turned off

JUPITER 1994

These photos were taken just 3 minutes apart with the same 10" scope; 22 sec at F/140 on color slide film. Note tiny Europa on the upper right, its shadow on the left, and cloud detail *inside* and around the Great Red Spot,... when the AO-2 is turned on!

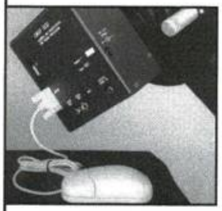
Use adaptive optics for better planetary photos! CCD adapter now available.

Runs off 12 V battery. $1290. For free color photos and technical info, call (800)-234-7729.

P.O. Box 720879
San Diego, CA 92172

CWIP-S DIGITAL **CCD**

Camera and Workstation for Image Processing



- Built-in processing
- No computer req'd
- Lightweight 12V unit
- Dark frame support
- Light frame support
- Fast, interactive
- Mouse-driven ease
- Still video output

Synthetic Clock Drive **works with non-motorized scopes**

NEW! 378 x 240 resolution with 12 bit precision

NEW! Digital videotape data storage & retrieval

NEW! Two-Color processing in camera

NEW! PC & Mac software with lossless image compression

NEW! Interpolated dark frames improve deep sky performance

Call or write for free information

SIRIUS INSTRUMENTS

141 N. Charles Ave
Villa Park IL 60181 USA
(708) 782-5819

$999

ASTRO FORUM

NASA's Needed Vision

by Eric Chaisson

That NASA is in trouble these days is an understatement. Our nation's space agency has gotten into a terrible cycle of lowballing the costs of its space missions to get them approved, overselling those missions to keep them funded (often despite large cost overruns) and, with few exceptions, failing to deliver on its promises. In a desperate attempt to keep its programs of interest to congressmen and third-graders alike, NASA tends to exaggerate everything.

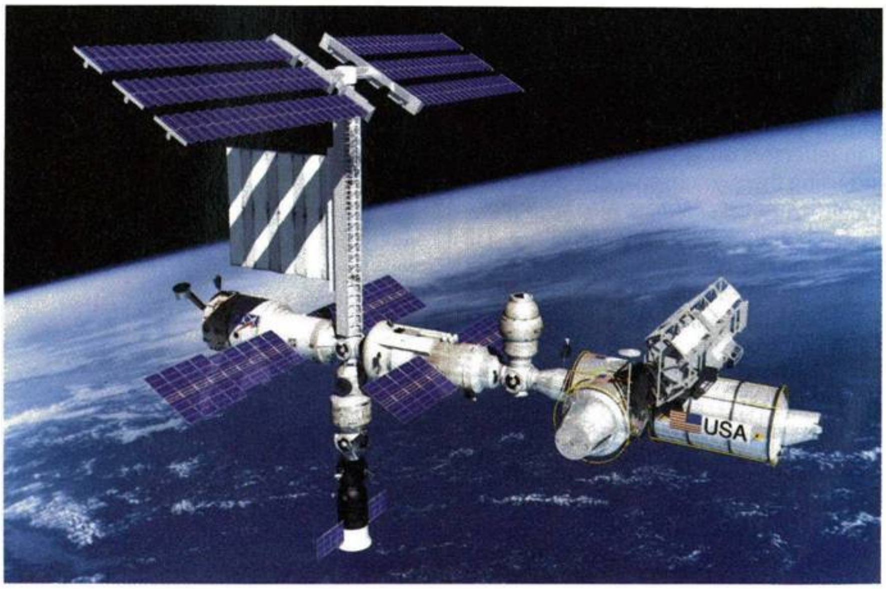
The exaggerations haven't helped because American taxpayers do not know what NASA is accomplishing. Nor do they seem to care anymore. Survey after survey in recent years has made it clear that the majority of people no longer get excited about what NASA does in space. This malaise regarding the final frontier is NASA's own doing because, first, it has made spaceflight seem boring and, second, it has no vision, no grand goal or understandable plan around which average citizens can rally.

"This vision does not include, in my view, the construction of a largely empty, hundred-billion-dollar garage called a space station."

Crewed spaceflight is risky and complex and it always has been so. Ask any astronaut or rocket engineer (but not a NASA manager) and they will tell you about the Apollo 1, Apollo 13, and Challenger accidents. Every space shuttle launch exposes the crew to danger. "When the shuttle's solid rockets light up and begin to vibrate, you really know you're going someplace," says astronaut Col. Charles Bolden, now deputy head of the U. S. Naval Academy.

Even for robotic spacecraft, risk and complexity are present. Take the vehicle I know the best, the Hubble Space Telescope. No one had ever before attempted to assemble such an intricate and complex apparatus, put it in orbit, and then operate it remotely. The four million lines of computer code needed to command and control it daily — one of the largest codes in the civilian world — is testimony to Hubble's high degree of complexity. And with complexity comes risk. Which in Hubble's case was exacerbated when no backup Space Telescope waited to be wheeled to the launch pad when the first one ran into trouble. "We flew the prototype," was the cry most often heard around my office when I was at the Space Telescope Science Institute.

The troubles with Hubble beg the question: What is an acceptable,



NASA

ON THE EVENING OF August 21, 1993, Steve Bisque in GOLDEN, COLORADO established modem contact with the 24-inch telescope at the Mt. Wilson Observatory *outside Pasadena...*

...he also grabbed a slice of history.

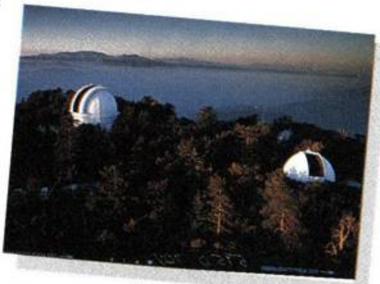
Using TheSky™ astronomy software and simple mouse clicks, Steve ordered the California telescope, more than 1,000 miles distant, to slew and lock on a medley of celestial objects. He collected more than a dozen images without a hitch.

It's hard to overstate this achievement. The applications of remote operation for professional, amateur, and scholastic astronomers are staggering.

*Still, we're no less proud of TheSky's other contributions to astronomy. Take, for instance, its highly acclaimed professional-quality star charts, CCD image processing, and stunning databases containing up to 19-million objects (including the Guide Star Catalog).**

There are simpler joys too, like its user friendly Windows™ interface, optional CD-ROM media, and simple upgrade path to professional versions. Not to mention lightning execution.

JUST FOR THE RECORD GLOBULAR CLUSTER M14 WAS THE FIRST CCD IMAGE TAKEN!



WHAT'S IN IT FOR YOU!

- Computer-Directed Telescopes
- Remote Astronomy
- CCD Astronomy
- Image Processing
- Professional-Quality Star Charts

With all this, it's easy to see why TheSky is the world's leading astronomy program for professional and amateur astronomers.

So pick up a copy of TheSky and take your own shot at history.

THESKY™
Astronomy Software

One Step Closer to the Ideal
1. 800. 843. 7599

Software Bisque
912 Twelfth Street, Suite A
Golden, Colorado 80401
Fax: 303. 278. 0045
International: 303. 278. 4478

SB SOFTWARE BISQUE

Acknowledgements:
Mt. Wilson Institute, California Institute of Technology, Merlin Controls Corporation, Meade Instruments Corporation, Santa Barbara Instrument Group, and Jet Propulsion Laboratories.

*ALL FEATURES ARE AVAILABLE IN THESKY REMOTE ASTRONOMY SOFTWARE.
THESKY IS A REGISTERED TRADEMARK OF SOFTWARE BISQUE.

The SHARPEST *Vues* — From Tele Vue and POCONO MOUNTAIN OPTICS!

Sale Prices in Effect

NAGLERS 82° Apparent Field of View — *Imagine a Walk in Space!*

Patented Tele Vue Naglers offer the widest, sharpest views available. Why settle for a back seat view when you can experience a *spacewalk*?

Choose from 4.8, 7, 9, 12, 13, 16 and the amazing 20mm!

Call us today for sharp prices and large selection!

PANOPTICS 68° Apparent Field of View — *Tack Sharp!*

Attack your sharpness problems with Tele Vue's newest eyepiece — the Panoptics. The 2″ 35mm and 27mm are considered to be the sharpest in their focal length class. The 1¼″ 22mm and 15mm offer outstanding performance, lighter weight, smaller size and lower cost when compared with similar focal length Naglers.

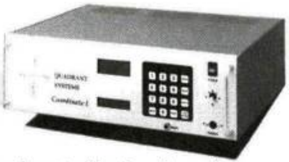
PLOSSLS 50° Apparent Field of View — *Tele Vue's Best Eyepiece Value!*

Patented Tele Vue Plossl eyepieces started the trend toward higher-quality, high-performance eyepiece designs. And today, despite the many imitators available, they still deliver the sharpest views in their class. And buying Tele Vue Plossls is the smart way to stretch your astro dollar. Our stock selection includes 1¼″, 7.4, 10.5, 13, 17, 21, 26, 32, 40 fl. And don't forget the 2″ 55mm, which yields the widest true FOV available.

Pocono Mountain Optics is your Tele Vue headquarters! Give us a call today, and see why our selection, price and service are second to none!

Pocono Mountain Optics
North Pocono Village Shopping Center, RR 6, Box 6329, Moscow, PA 18444
P. List — send SASE
with .58¢ in stamps
No surcharge for credit cards
Showroom Hours 10 am-5 pm
Monday thru Saturday
Cat. $6.00 (within U.S.)
$9.00 to Canada
$10.00 Elsewhere
$5.00 MINIMUM SHIPPING
U.P.S. (IN U.S.)
(Orders) Toll Free: 800-569-4323 till 9 p.m. 7 days a week (info) 717-842-1500 till 9 p.m. FAX 717-842-1408(24 hrs.

QUADRANT SYSTEMS
Professional
Telescope Guidance Controllers



Quadrant Systems offers the most accurate, versatile and cost effective line of telescope guidance controllers on the market. Designed for amateurs as well as professionals, the COORDINATE line of controllers are used with all types of telescopes—from professional sites at McDonald Observatory, to sophisticated home observatories.

Designed for portable or fixed site operation, the COORDINATE controller line contains all the features necessary for professional telescope operation:

- Precise slewing and tracking with digital frequency synthesizers
- Points with arc second resolution (digital setting circles included)
- 24 hour real time clock with LT, GMT, LST, or GST display, plus stopwatch timer
- Interfaces for TheSky, Astrolink and other astronomy software
- Autoguiding with SBIG ST-4, ST-6 and other CCD cameras or manual guiding with paddle or joystick

Optional items include: hand paddle, NGC 2000 database, third motor axis, dome control, CCD autoguiders and a full range of stepper motors, gears and mounting items.

Complete systems begin at $1,295. Call, write or fax for free brochure.

Quadrant Systems
P.O. Box 370
Oregon House, CA 95962
(916) 692-2563 TEL
(916) 692-2538 FAX

informed risk? Reducing the risk of failure until it approaches zero would make the testing required for such a complex mission impossibly expensive. Shunning risk altogether would be tantamount to avoiding tasks never before done. Risk-taking is a hallmark of all civilizations that become great — they become great partly because they occupy new ground, achieve victory, and accomplish notably new things.

The willingness to risk failure is an essential ingredient of most grand initiatives, the kind of ventures that leave legacies for our descendants. The fact that risk is an inherent element of space operations is something the current NASA, the "new NASA," does not seem to understand. Since Apollo, the space agency has tried hard to make both crewed and robotic spaceflight seem routine — an attempt that unfortunately has largely succeeded. It has sought to generate a perception that spaceflight is risk free, that politicians can travel into space safely along with journalists and teachers, too.

In the Mercury, Gemini, and Apollo days, the public recognized fully that risk was an integral part of those missions and responded to them with enthusiasm. Now, with NASA's hype and bravado reinforcing the perception that space missions are easy to accomplish and routine to undertake, the twin elements of adventure and exploration have been diminished, and the public has responded accordingly — by becoming bored with the space program. NASA, once more, has shot itself in the foot, for Americans would rather know the truth about the risks of space science and engineering and, thus, partake in the spirit of adventure.

The U. S. space agency is in desperate need of leadership: technically competent people who can set ambitious and productive goals for NASA and articulate those goals clearly and accurately before the American public. The taxpaying citizen has always welcomed the exploration of space, the adventure into the unknown. It may well be our manifest destiny to negotiate the next frontier. And the "old NASA" should be commended for taking the early steps to move our species — intellectually and physically — in that direction.

If the management of the "new NASA" were to explain effectively, using technical truth and withholding hype, a vision and rationale for the agency's many varied programs, it would not likely experience its annual budget crisis, its periodic congressional micromanagement, the ongoing lack of public confidence, and the deep and bitter frustrations within the agency itself. Lacking such ability — and the sense of trust that derives from it — the space agency instead has solidified into a bureaucratic morass that rewards mediocrity and self-preservation while damping creativity and innovation.

What might NASA's vision be? It could be a crewed mission to Mars or the establishment of a permanent lunar colony. It might be a thorough robotic exploration of virtually every nook and cranny in our solar system. Or it might be a vision capable of exciting people by systematically addressing some of the time-honored philosophical questions about the nature of the cosmos.

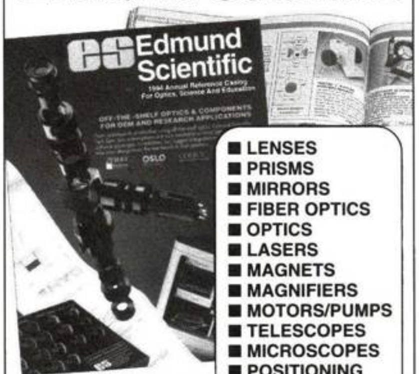
To my mind, that vision should be an intellectual attack on the scenario of cosmic evolution: a space program dedicated to understanding better who we are, where we've come from, and how we fit into the cosmic scheme of things. Such a vision that is articulated well, honestly, and understandably to the taxpayer — thus inviting our fellow citizens to share in this great journey, to feel like a participant and not just a spectator — could indeed leave a legacy.

But this vision does not include, in my view, the construction of a largely empty, hundred-billion-dollar garage in the sky called a space station. Nor will it be a potpourri of scattered space-science objectives run by people who feel that NASA owes them something, like an entitlement program for scientists who want to play in their favorite sandbox or engineers who simply want a job. And most definitely, it will not be a vision created by some Beltway-bandit advertising firm like those that currently try to mold the image of the "new NASA."

It's time for us to become a genuine spacefaring nation that goes boldly toward new frontiers. But to do so, our space program needs the support and understanding of its populace. And right now that support is not there because NASA has not provided the understanding. ☐

Eric Chaisson authored The Hubble Wars: Astrophysics Meets Astropolitics in the Two-Billion-Dollar Struggle Over the Hubble Space Telescope *(HarperCollins, 1994). He recently left the Space Telescope Science Institute to join the faculty at Tufts University.*

Edmund Scientific



- LENSES
- PRISMS
- MIRRORS
- FIBER OPTICS
- OPTICS
- LASERS
- MAGNETS
- MAGNIFIERS
- MOTORS/PUMPS
- TELESCOPES
- MICROSCOPES
- POSITIONING EQUIPMENT
- COMPARATORS
- EYEPIECES

FREE

Reference Catalog For Your Technical Library

236 Pages, Over 8000 Products

Our new, full color catalog describes one of the largest and most diversified lines in the nation of precision lenses, optics and optical instruments plus many hard-to-find scientific and technical products used in science, industry and by researchers.

Write, call or FAX for your FREE copy today.

TEL: 1-609-573-6250 **FAX:** 1-609-573-6295

Serving Industry For Over A Half Century

Edmund Scientific

Dept. 15B1, N964 Edscorp Bldg., Barrington, NJ 08007

Attention Please:

LOSMANDY PRECISION EQUATORIAL MOUNTS

GM8, G11, GM200,
Equipment Load Capacities
from 30 lbs to 150 lbs

Expert Sales & Service

Complete Secondary System Hardware for Any Imaginable Equipment Combination!

Call Mon-Fri
9 to 5 Calif time. (800) 735-1352

or Write or Fax for Free Brochure

NEW! from Spectra Astro • Systems ™

fax# 818-996-7698...24 hrs
6631 Wilbur Ave., Suite 30
Reseda, CA 91335

High-Definition

These two words best describe the performance of the HD145 (5.7") and HD216 (8.5") Maksutov-Newtonian telescopes.

The HD145 5.7" f/6
Tube Assembly starts at $1895.
Maksutov-Newtonian telescope
Literature $5, $10 overseas

Being an active amateur astronomer for over 20 years and always searching for the "perfect telescope," my quest has finally ended. After comparing my HD145 to several high-quality, high-priced apo-refractors under excellent seeing conditions for five consecutive nights, I found the HD145 offered equal or better performance, aperture for aperture, yet is much less expensive.
— Richard J. Whelan
Clearwater, Florida

CERAVOLO*Optical Systems* (613) 258-4480 Fax 258-3082

Box 151, 702 Pattersons Crns. Rd.
Oxford Mills, Ontario, Canada
K0G 1S0

In the United States:
Box 1427, 812 Proctor Ave.
Ogdensburg, NY 13669

Hubble Finds Hidden Quasar Nearby

Astronomers have discovered a powerful quasar buried deep within the dusty heart of the radio galaxy Cygnus A. Because quasars typically lie billions of light-years from Earth, scientists were surprised to find one at the relatively close distance of 600 million light-years, virtually in our cosmic backyard. The discovery gives astronomers a nearby example to study in detail.

Anne Kinney of the Space Telescope Science Institute in Baltimore, Maryland, said "I was stunned when we realized we had a quasar; it was a total surprise." Kinney, along with Robert Antonucci and Todd Hurt of the University of California at Santa Barbara, discovered the quasar with the Faint Object Spectrograph on the Hubble Space Telescope. They reported their results in the September 22, 1994 issue of *Nature*.

The nucleus of Cygnus A, the second strongest radio source in the sky, lies hidden behind a dark band of dust that gives the galaxy an unusual peanut shape when viewed in visible light. The team could see into the core only because dust outside the nucleus acts like a mirror and reflects the shorter wavelengths of light toward Earth.

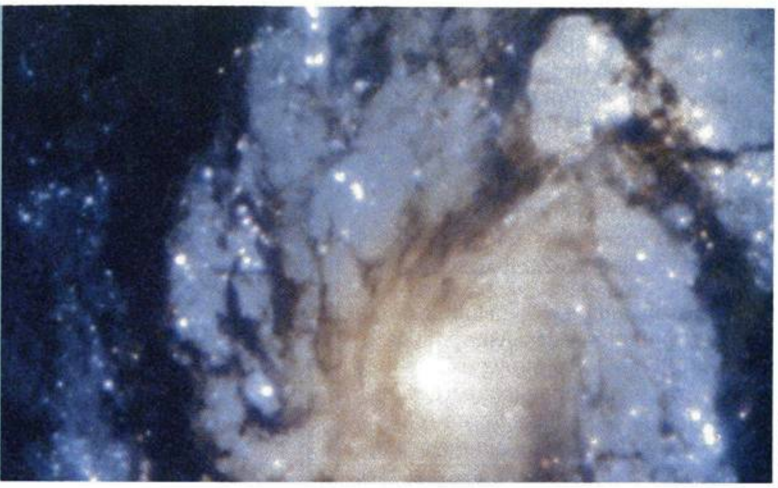
They took an ultraviolet spectrum of the nucleus' light hoping to find the signature of extremely hot, massive stars, which many astronomers think power Cygnus A's strong optical emission. Instead they got a spectrum featuring a broad emission line of ionized magnesium. The broad emission line, which indicates gas swirling at high speed, along with the nucleus' high luminosity indicates unambiguously the presence of a quasar inside Cygnus A. The astronomers now suspect that quasars

ASTRONAUT MARK LEE FLOATS FREE of the space shuttle Discovery some 150 miles above Earth. During Discovery's September flight, Lee and fellow astronaut Carl Meade tested the new Simplified Aid for EVA Rescue system, designed to stabilize astronauts and return them to safety if they accidentally drift away from the space station.

NASA

HOW FAR TO VIRGO? That's a question with a new answer, thanks to two research groups working independently. One group, led by Michael Pierce of Indiana University, derived a new distance to the Virgo cluster of galaxies using Cepheid variable stars in NGC 4571. The distance for the cluster, they found, is 45 to 50 million light-years. A team led by Wendy Freedman of the Carnegie Observatories echoes these findings. Her team used the Hubble Space Telescope to survey Cepheids in M100 (right) and NGC 4571 and found nearly the same results.

The new distance implies the universe is only 8 to 10 billion years old, roughly half as old as its oldest stars. Neither team could explain the paradox.



NASA/STScI

Own the first and only official re-creation based on the game actually played by Captain Kirk™ and Mr. Spock™...

THE OFFICIAL

STAR TREK®

TRIDIMENSIONAL CHESS SET

PARAMOUNT PICTURES presents the spectacular three-level chess set of the future. Rich with Silver and Gold.

It's the ultimate chess challenge! The intergalactic game of the future, as seen played aboard the legendary starship U.S.S. ENTERPRISE.™ A spectacular showpiece–moving the STAR TREK® saga into a bold new dimension.

And now Paramount Pictures invites *you* to own *the first and only authorized re-creation* based on the famous set introduced by Captain Kirk and Mr. Spock in the classic episode "Where No Man Has Gone Before."™

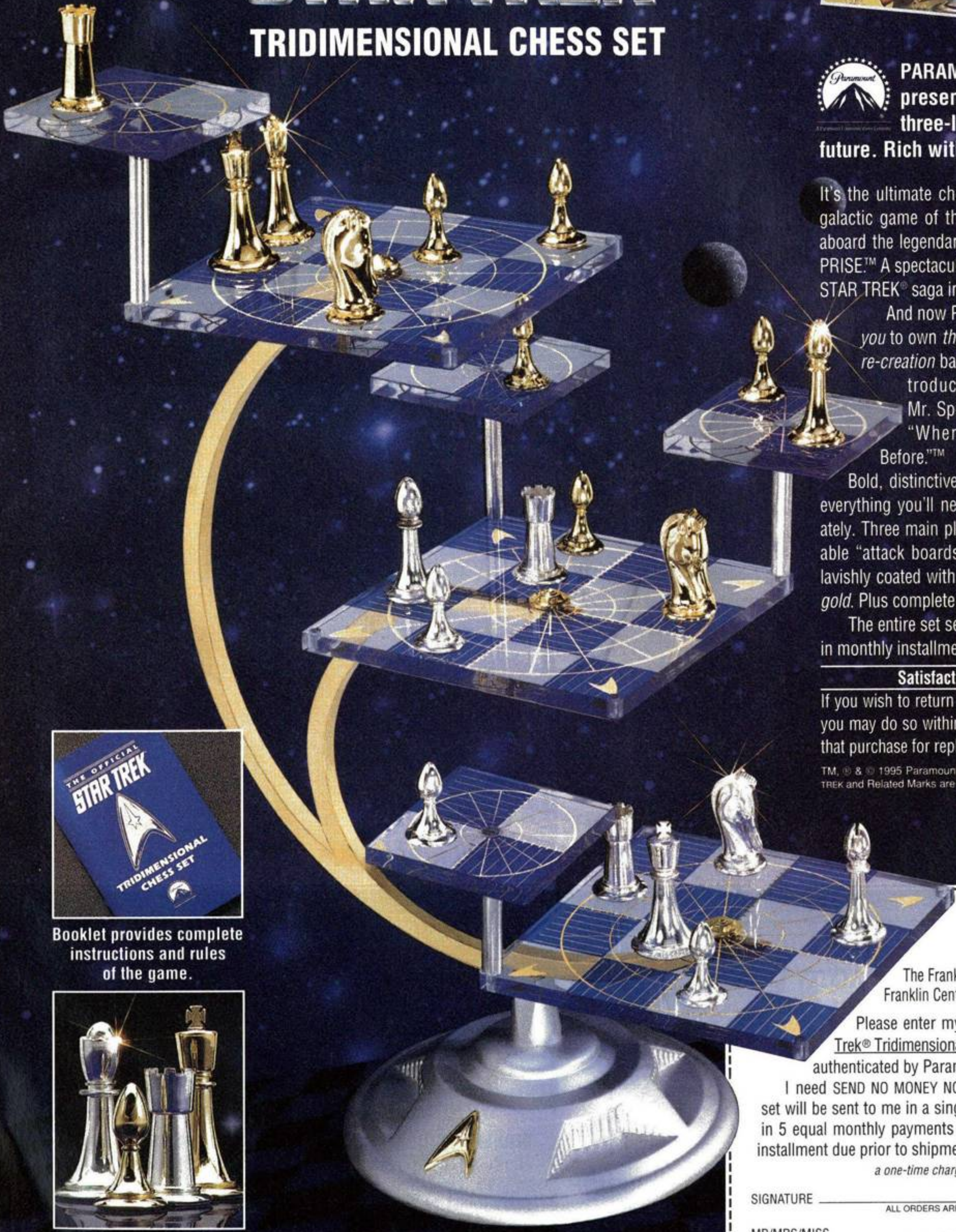
Bold, distinctive, eminently logical, it has everything you'll need to begin play immediately. Three main playing boards. Four moveable "attack boards." 32 game pieces, each lavishly coated with *sterling silver* or *24 karat gold*. Plus complete playing instructions.

The entire set sent at one time. Just $195, in monthly installments.

Satisfaction Guaranteed

If you wish to return any Franklin Mint purchase you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

TM, ® & © 1995 Paramount Pictures. All Rights Reserved. STAR TREK and Related Marks are Trademarks of Paramount Pictures.



Booklet provides complete instructions and rules of the game.

Game pieces each lavishly coated with sterling silver or 24 karat gold.

Game boards measure 13¼" (33.66 cm) tall x 6⅛" (15.56 cm) wide x 10¼" (26.04 cm) deep.

THE ULTIMATE CHALLENGE!

Please mail by Stardate 9531.01.
(January 31, 1995.)

The Franklin Mint
Franklin Center, PA 19091-0001

Please enter my order for The Official Star Trek® Tridimensional Chess Set, authorized and authenticated by Paramount Pictures.

I need SEND NO MONEY NOW. The complete imported set will be sent to me in a single shipment. I will be billed in 5 equal monthly payments of $39.* each with the first installment due prior to shipment. **Plus my state sales tax and a one-time charge of $3. for shipping and handling.*

SIGNATURE ____________
ALL ORDERS ARE SUBJECT TO ACCEPTANCE.

MR/MRS/MISS ____________
PLEASE PRINT CLEARLY.

ADDRESS ____________ APT. # ______

CITY/STATE ____________ ZIP ______

TELEPHONE # (______) ____________

16863-5-001

may be common in powerful radio galaxies, a hypothesis they plan to test by observing other such galaxies.

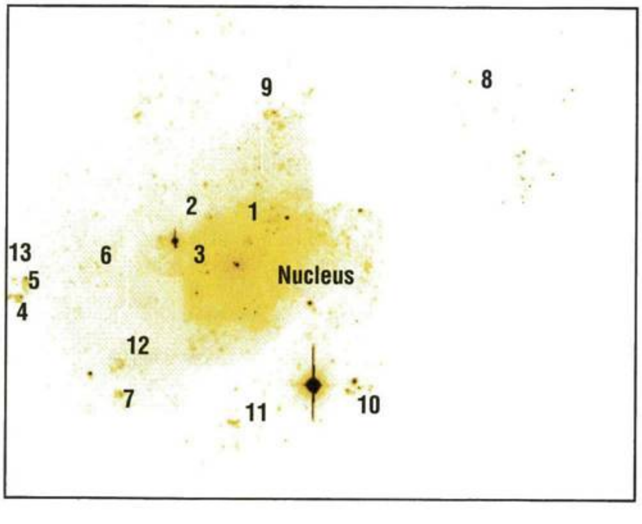
A Fall into the Sun

The fate of many Earth-crossing asteroids will be to fall into the Sun, says a team of European celestial mechanicians. This finding, published in the September 22, 1994 issue of *Nature*, is the outcome of long-term computer modeling of asteroid orbits. The team found that nearly a third of the asteroids they studied will fall into the Sun on time scales of 2 million years or less. The new results corroborate studies of short-period comets. The studies show about 6% become Sun-grazers over about 500,000 years. But most dynamical astronomers had previously felt that planet-crossing asteroids would more likely collide with one of the planets.

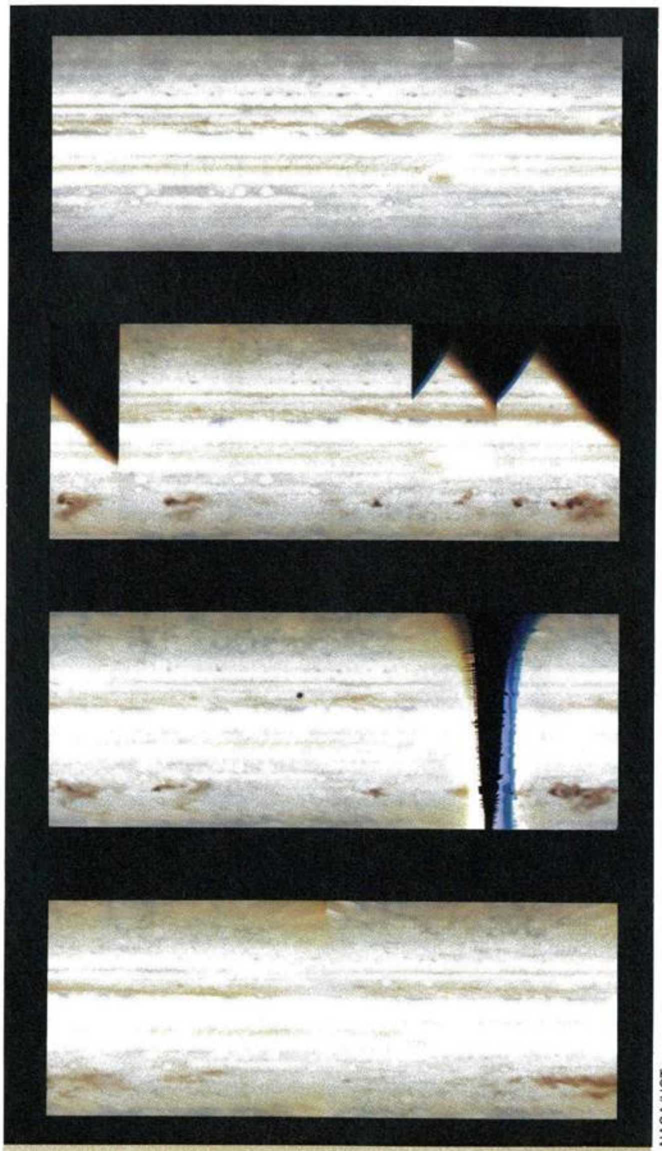
The researchers, led by Paolo Farinella of the University of Pisa in Italy, used numerical integrations to predict the fates of 47 asteroids with orbits that either cross Earth's or approach it. They found that in the 2.5 million years of the integration, 15 of the objects will strike the Sun and four of them will be ejected from the solar system. For example, among the ejected is 4179 Toutatis, which will be sent on its way in about 640,000 years, while Comet Encke, a nearly inactive short-period comet (and the probable parent body of the Taurid meteor shower), will collide with the Sun in about 90,000 years. The researchers caution, however, that these orbits are highly chaotic and thus the specific results of the calculations should not be taken as precise predictions. Rather these indicate simply that a large fraction of all asteroids with Earth-crossing orbits will fall into the Sun.

Hot, Luminous, with Strong Winds

Wolf-Rayet stars can tell astronomers much about the abundance of heavy elements in other galaxies and, thus, how galaxies change with age. Over the past five years, Gérard Testor of the Observatoire de Paris in France and Hansreudi Schild of University College London in the United Kingdom have explored the spiral galaxy NGC 300 in the Sculptor Group, using the telescopes at the European Southern Observatory in La Silla, Chile. At a distance of about 5 million light-years, the Sculptor Group ranks as the nearest galaxy group to our own Local Group. To date they have identified 13 Wolf-Rayet candidates in NGC 300 and confirmed 11 of them. (The photo is a mosaic showing all 13 candidates and the parts of NGC 300 surveyed so far.) Using current ESO equipment and the Very Large Telescope once that comes on line in the late 1990s, the researchers plan to continue their survey of Wolf-Rayet stars to study the heavy-element content of NGC 300.



G. Testor and H. Schild

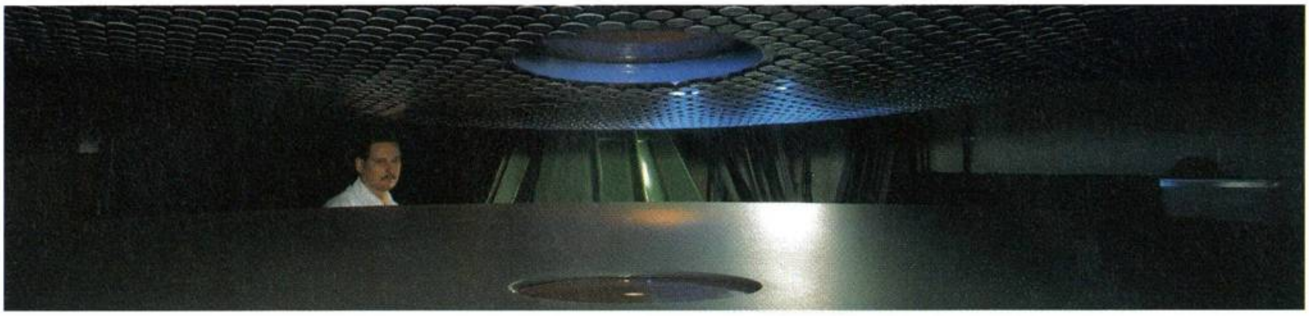


NASA/HST

BRUISES FROM COMET SHOEMAKER-LEVY 9 parade across Jupiter in mosaics made by the Hubble Space Telescope on July 15, 1994 (top, before the first impact), July 23, July 30, and August 24. Hubble's observations suggested the object was a comet rather than an asteroid, discovered unusual auroral activity in Jupiter's northern hemisphere, and observed the wind jets that smeared the bruises.

1897: ***First astronomical telescope from Carl Zeiss***
1993: ***World record in manufacturing high-precision aspheres for large astronomical optics: 3.5m Galileo Telescope***
Results: ***Tens of thousands of high-quality astronomical telescopes for pros and amateurs, universities and schools. Outstanding track record in terms of optical and mechanical parameters.***
Countless successful projects in cooperation with astronomical institutions throughout the world.

Made for the Discoverers of Today



The 3.6m primary mirror, the heart of the Galileo telescope during processing at Carl Zeiss.

APQ 150/1200 Refractor on Model II Equatorial Mount

NASA trusts Zeiss products. Objectives from Carl Zeiss have been reliable companions in their manned missions. All Apollo landings on the Moon were documented by them. The name of Zeiss is a symbol of precision.
The technical standards applied to Zeiss objectives and Zeiss' expertise in manufacturing large telescopes, determine the unmatched performance parameters and the outstanding quality of the new APQ refractors for amateur astronomers and nature lovers. APQ is a special fluorite objective, a fully apochromatic triplet, which does not need air gaps due to an advanced oil-spaced design. APQ guarantees top transmission and highest color purity.

Carl Zeiss – *seeing more than others.*

Beware! A flirt with an APQ easily turns into a great passion.
Get involved – Call today for a free brochure: 1-800-489-2282

SEILER
INSTRUMENT

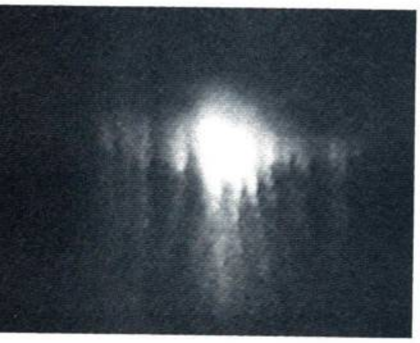
Seiler Instrument & Manufacturing Co.
170 East Kirkham Avenue
St. Louis, Missouri 63119-1791
Phone: 314-968-2282
Fax: 314-968-2637

ZEISS

Carl Zeiss Jena GmbH
Zeiss Group
Astronomical Instruments Division
D-07740 Jena
Germany

Gamma-Ray Flashes in Earth's Atmosphere

When NASA launched the Compton Gamma Ray Observatory in April 1991, scientists anticipated getting their first detailed views of gamma-ray sources lying deep in space. They never expected to observe gamma rays arriving from below the spacecraft, emanating from Earth itself. But that's just what they have seen — brief, intense flashes of gamma rays originating in our planet's upper atmosphere.

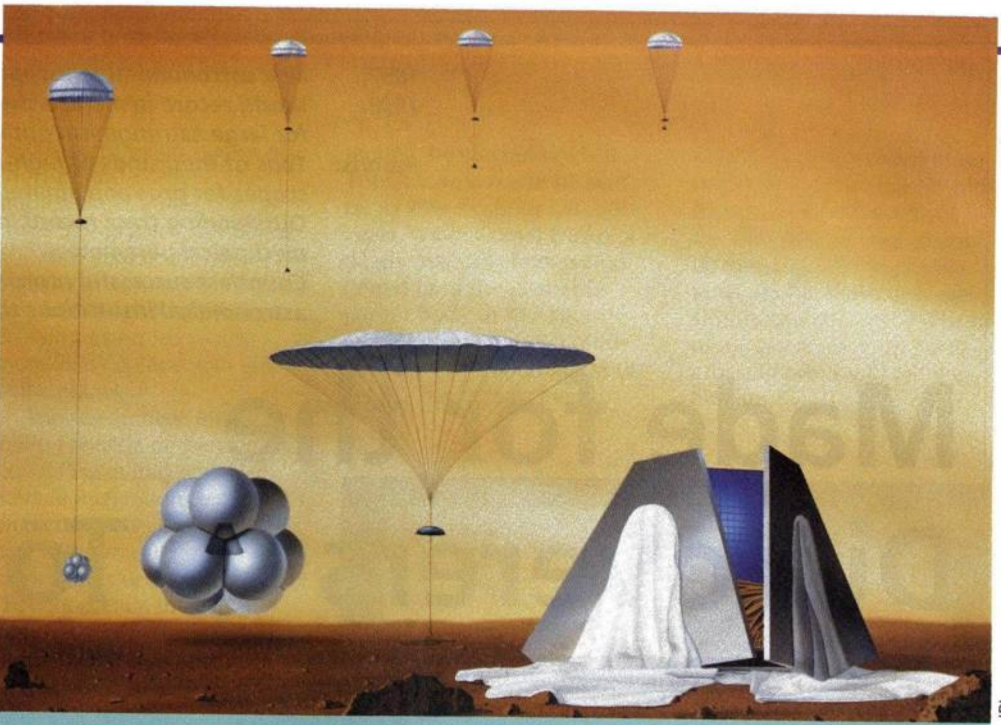


Walter A. Lyons, Mission Research Corp.

LIGHTNING — OR SOMETHING LIKE IT — lights up the stratosphere above a Midwestern thunderstorm complex. This structure appeared roughly 40 to 50 km high on July 7, 1993. Similar electric discharges may emit intense flashes of gamma rays detected by the orbiting Compton Gamma Ray Observatory.

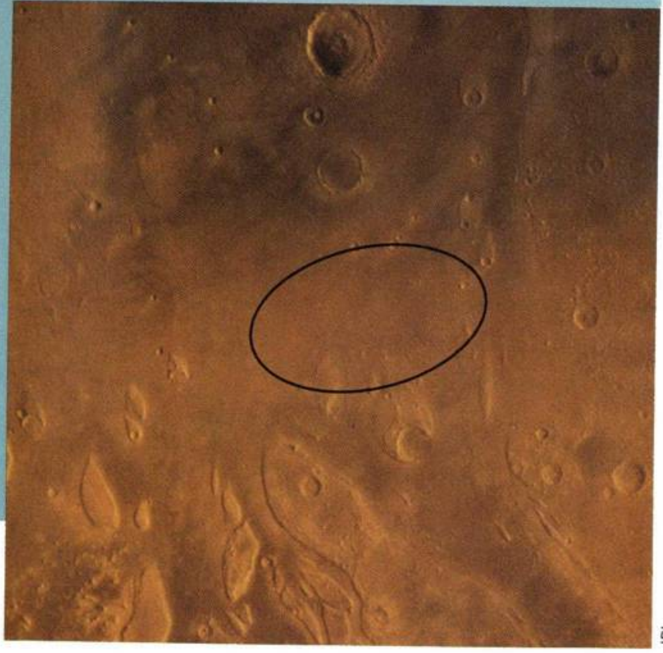
Using the Burst and Transient Source Experiment onboard the observatory, Gerald Fishman of NASA's Marshall Space Flight Center in Huntsville, Alabama, and his colleagues have detected at least a dozen of these flashes. They last just a few thousandths of a second and contain very high-energy gamma rays, even higher than those in a typical gamma-ray burst.

To avoid being absorbed within the atmosphere, the gamma rays must originate at least 30 kilometers above Earth's surface, in either the stratosphere or ionosphere, well above normal weather phenomena. High-energy electrons in this region evidently emit the gamma rays. Noting an apparent correlation of the flashes with intense thunderstorm complexes, the scientists speculate that the electrons arise in powerful electrical discharges, similar to lightning. Although such discharges have been seen from high-flying aircraft and the space shuttle, until now no one suspected they emit gamma rays.



JPL

A PARACHUTE AND SET OF AIRBAGS delivers the Mars Pathfinder lander safely to Mars' surface in 1997 (above). Nestled behind fold-down panels is a microrover experiment. The lander/rover combination will land at the mouth of an ancient river channel, Ares Vallis, where water flowed eons ago. Pathfinder's target zone, shown on a Viking orbiter picture at right, is 60 by 120 miles wide and lies 527 miles southeast of Viking 1's lander site.



JPL

Meteorite Crater Under Chesapeake Bay?

About 35 million years ago a large meteorite blasted a crater at least 85 km across at the mouth of what is now Chesapeake Bay, says C. Wylie Poag of the U.S. Geological Survey in Woods Hole, Massachusetts. Poag and fellow USGS scientists identified what they believe to be a buried impact crater using seismic reflection techniques to image rock layers under Chesapeake Bay. They also studied jumbled sediments found on land in Virginia and the Delmarva peninsula; their report was published in the August 1994 issue of *Geology*.

The seismic profiles show disturbed rock layers below the present bay floor that resemble a cross section of an impact crater. The land outcrops contain broken rocks and jumbled sediments that the team interprets as

Meade®

ADVANCED PRODUCTS

Get the most for your money this Holiday Season

#285
$299

#227
$199

#390
$499

#395
$599

1994 Best Buy

#4500
4.5 Inch Diameter
910mm Focal Length
6x30 FinderScope • 25mm Eyepiece
Equatorial Mount
w/Adjustable Aluminum Tripod

$399

FREE SHIPPING IN CONTINENTAL U.S. FOR ABOVE ITEMS!!!

LX200 8" & 10"
StarFinder 6, 8 or 10"
APO Refractors
ALL IN STOCK!

WE STOCK THE FULL LINE OF MEADE TELESCOPES & ACCESSORIES. PLEASE CALL AND WE WILL BE HAPPY TO ASSIST YOU!

1-800-359-5085

PRECISION OPTICS
CITY camera

15336 W. WARREN • DEARBORN, MICHIGAN 48126
(313) 846-3922 • (800) 359-5085 • FAX (313) 846-4450

Hours (EDT)
Monday-Friday 9-6
Saturday 9-5:30

Visa • MasterCard
Discover
American Express
Welcomed with no extra charge!

coming from tsunamis (commonly referred to as tidal waves). At the time of impact, the site was about 100 km offshore.

The geologists think the crater could also be the source for a field of tektites that stretches from Barbados to New Jersey to Texas. Tektites are glassy rocks formed when impact-melted rock is flung high into space, chills quickly, and falls again to Earth.

Poag and his colleagues are now searching through the deposits looking for the telltale signs of high-velocity impact shocks. These are considered by geologists to be diagnostic of meteorite impacts.

Fewer Novae in the Galaxy

Novae are created and brighten by as much as ten magnitudes when material from a star in a binary system falls on its white dwarf companion. Until recently, the number of novae that occur each year in our Milky Way Galaxy has remained uncertain, with estimates ranging from 10 to 100 per year. Determining the number from observations of stars in the Galaxy is difficult because distant novae are hidden by dust and the glare of nearby stars.

So, a pair of astronomers looked at the nova rates in other nearby galaxies, noting that the rate depends upon the infrared luminosity of the galaxy and whether it's a spiral or elliptical. Massimo Della Valle of the European Southern Observatory in La Silla, Chile, and Mario Livio of the Space Telescope Science Institute in Baltimore, Maryland, used the rates for the Large Magellanic Cloud, M33, M31, NGC 5128, and three ellipticals in the Virgo Cluster to estimate the rate for our Galaxy. They reported their result, a modest 15 to 24 novae per year, in the June (III) 1994 *Astronomy and Astrophysics.*

AMATEUR NEWS

A Midwest Gateway to the Stars

Here's a formula for a weekend of star party success: Lease a campground that's far from city lights, sign up lots of guest speakers, invite more than a dozen commercial vendors, and provide them all with plenty of room for a swap meet. That's how the Chicago Astronomical Society's been organizing Astrofest for 15 years. They must be doing something right. Astrofest 1994 drew a record 789 observers, astrophotographers, and telescope makers from all over the country to Camp Shaw-Waw-Naw-See, 10 miles west of Kankakee, Illinois, on September 9-11.

This year's attendees filled the camp's main field edge-to-edge with a variety of scopes up to 30 inches in aperture. Clear night skies for the better part of Friday and all of Saturday didn't disappoint those who brought a scope. For people in the market for new or used equipment, vendor displays and a swap meet ran Friday afternoon and most of Saturday.

The market adjoined a dining hall where talks were presented all day Saturday. Illinois observer Randall McClelland shared his design for a portable viewing chair that accepts binoculars or a small telescope. John Dykla from Ohio outlined how changes in Earth's climate affect the appearance of earthshine on the Moon. Keynote speaker Richard Berry, author of *The CCD Camera Cookbook*, proposed several "lifelong" projects that amateurs with CCD cameras can undertake, including keeping tabs on the Moon for changes and monitoring certain nebulae that change appearance. With the powerful potential of the CCD, Berry thinks amateurs will make valuable contributions to astronomy.

For information about 1995's Astrofest, planned for September 15-17, write Astrofest, P.O. Box 596, Tinley Park, IL 60477.

League Spotlights Young Astronomers

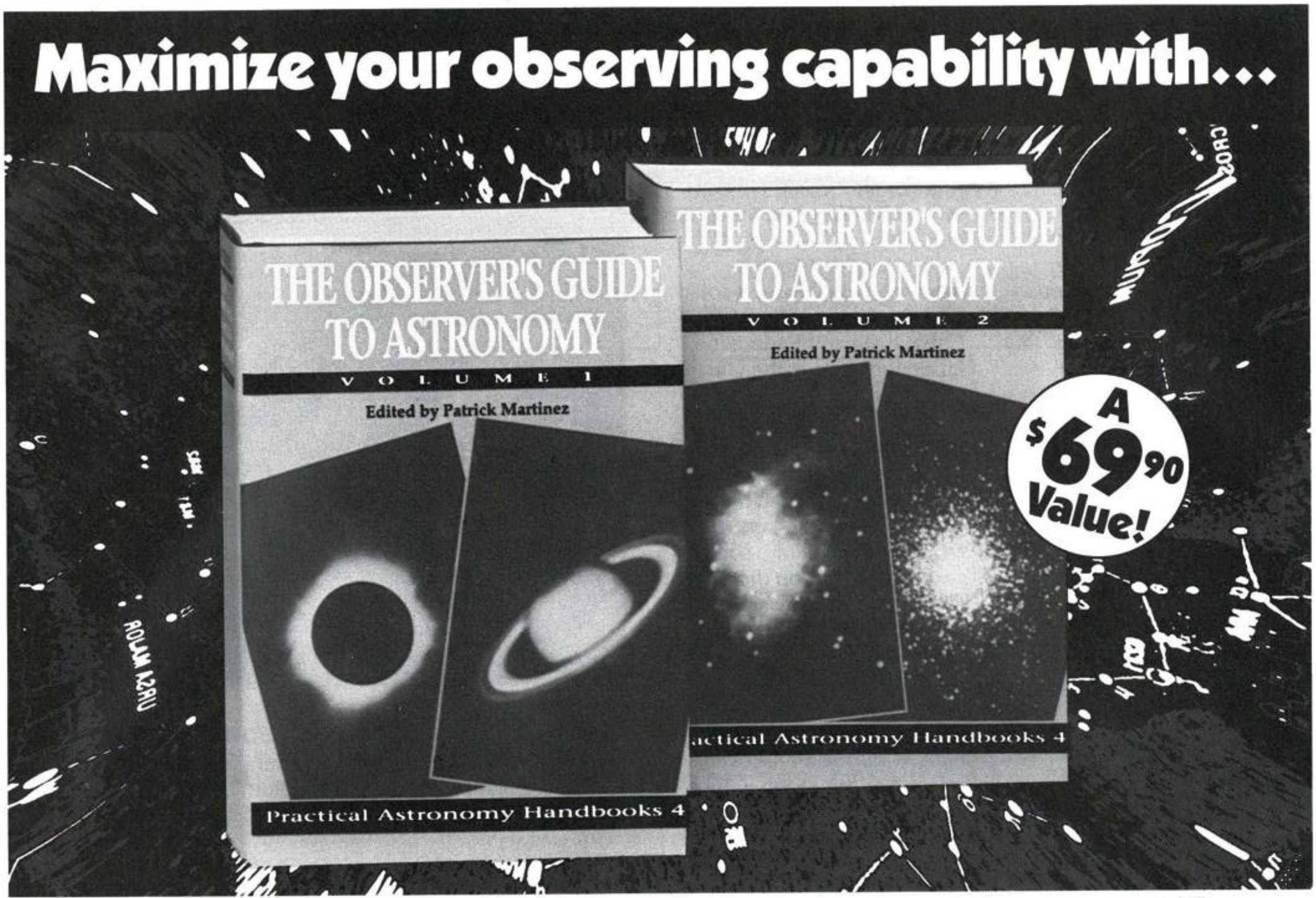
At their annual meeting July 30, the Astronomical League presented its National Outstanding Young Astronomer Award (NOYAA) to Stephanie Cinereski, 17, of Gainesville, Florida. Cinereski studies sunspot phenomena visually and with a radio receiver. She used a magnetometer to verify that sunspot groups erupt closer to the equator with the approach of solar maximum. Cinereski also investigates the relationship between sunspots and solar flares.

Runner-up John Barentine, 17, of Phoenix, Arizona, uses CCD and video cameras to study how the density of several major meteor streams change with time. Third place winner Michael Deming, 17, of Mauriceville, Texas, works extensively in public astronomy education throughout southeast Texas.

For 1995 NOYAA nomination information, write Robert Gent, 718 Stoneway Dr., San Antonio, TX 78258 or Charles Allen, 1007 Rollingwood Lane, Goshen, KY 40026. Send tax-deductible contributions to the NOYAA scholarship fund to either address.

OUTSTANDING YOUNG ASTRONOMER Stephanie Cinereski receives the Astronomical League's 1994 National Outstanding Young Astronomer Award from League president Jim Fox.

Bob Gent


THE OBSERVER'S GUIDE TO ASTRONOMY
VOLUME 1
Edited by Patrick Martinez
Practical Astronomy Handbooks 4
THE OBSERVER'S GUIDE TO ASTRONOMY
VOLUME 2
Edited by Patrick Martinez
Practical Astronomy Handbooks 4
A $69.90 Value!

Maximize your observing capability with...

The 2-volume Observer's Guide to Astronomy

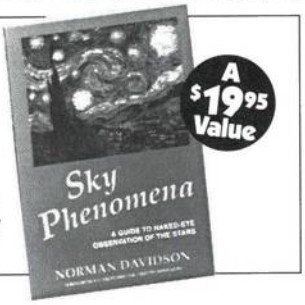
yours for only $2.95

as your introduction to the ASTRONOMY BOOK CLUB

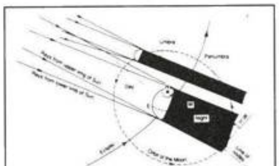
You simply agree to buy 3 more books — at significant savings — within the next 12 months.

Yours FREE!

Sky Phenomena is a practical guide to naked-eye astronomy. Simple but revealing day-to-day exercises show you how the sky works. You'll also see how astronomy was practiced through history and celebrated in the arts.



Astronomical observations can be difficult if you don't have the right tools. To make your observations more meaningful and interesting, you'll find the 2-volume *Observer's Guide to Astronomy* is as essential as a telescope.

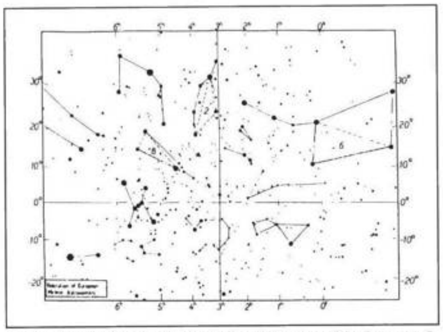


Schematic diagram showing the conditions under which the Moon's shadow may be intercepted by the Earth, producing a total eclipse of the Sun.

You get valuable star maps, scientific background, and concise directions on recording and cataloging observations using professional terminology and classification schemes. Find out how to:

- Observe the sun, moon, planets, stars, and deep-sky objects
- Locate new minor planets, comets, and novae
- Track artificial satellites
- Measure the temperatures of stars
- Photograph meteors and other objects
- Use photoelectric photometry and image intensifiers

Just complete and mail the postage-paid reply card today to get the 2-volume *Observer's Guide to Astronomy* for only $2.95 and a FREE gift.



Example of a gnomonic chart. The distortion of the Square of Pegasus at top right is particularly noticeable.

The Astronomy Book Club

Whether you're a professional or amateur enthusiast, the Astronomy Book Club offers you the finest astronomy materials available. You'll enjoy atlases and how-to manuals, as well as textbooks and popular guides covering the latest discoveries, and the opportunity to purchase them conveniently and inexpensively. All books are available to you at significant savings, with prices starting as low as $9.95.

MEMBERSHIP BENEFITS In addition to getting the 2-volume *Observer's Guide to Astronomy* for only $2.95, and *Sky Phenomena* FREE when you join, you keep saving substantially with discounts of up to 50% off the publishers' prices on books you choose to purchase. • Also, you will immediately become eligible to participate in our Bonus Book Plan. • Moreover, our books are always identical to the publisher's editions. You'll never receive an "economy edition" with inferior paper and bindings from us. • At 3-4 week intervals (16 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • In addition, up to four times a year, you may receive offers of Special Selections which will be made available to a group of select members. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

If reply card is missing, please write to Astronomy Book Club, Dept. L-DP2, 3000 Cindel Drive, Delran, NJ 08370-0001, for membership information and an application.

Astronomy 1/95 ©Newbridge Communications, Inc.

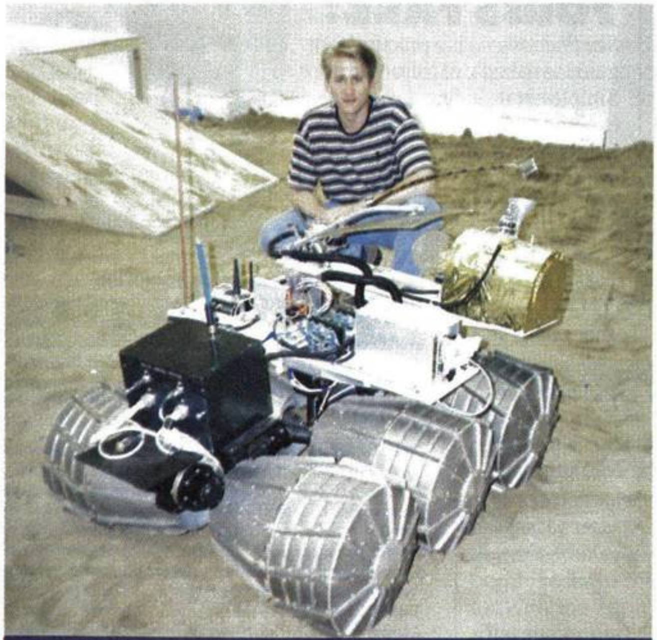
Have Oxygen, Will Travel

If astronauts are going to survive long stays on the Moon, they'll need copious amounts of oxygen for air and fuel. An engineering model developed by the University of Arizona of a machine that cracks oxygen from lunar soil passed with flying colors during tests held in Moscow, Russia, July 20. The cracker, mounted on a prototype lunar rover, was operated remotely from Arizona by engineers who commanded the rover to collect soil from seven different sample sites in a simulated lunar environment.

A scoop on the rover dumped each soil sample into a processing chamber in preparation for oxygen processing. This test did not produce oxygen, but was intended to prove that the Russian craft could collect soil and deliver it to the cracker.

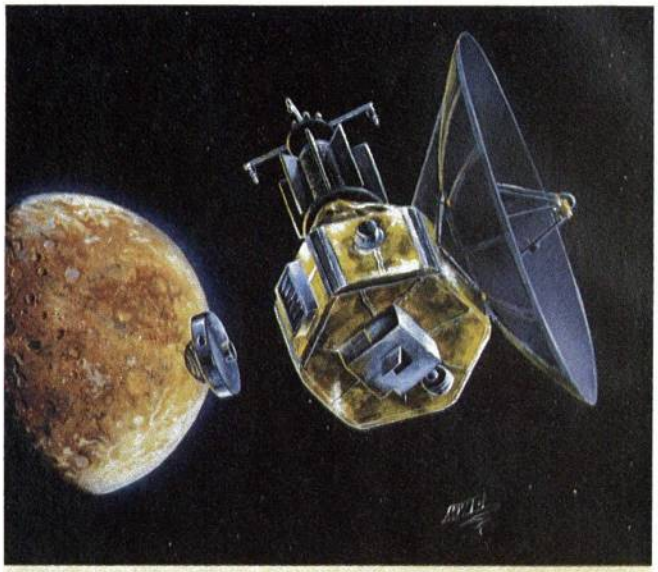
The workings of the machine, which uses a solar furnace to heat soil to 1,000° C, have already undergone laboratory tests at the University of Arizona. In one chamber of the processor metal oxides in the soil react with a carbon-impregnated mesh to form carbon monoxide. A second chamber converts the CO into solid carbon and carbon dioxide. Finally, an electrolysis cell extracts oxygen from the CO_2.

NASA and Rockwell International want to fly a working version of the cracker during a Discovery mission to the Moon, which might take place as early as 1996. Latest plans call for the mission to use a Russian-designed rover. □



K. R. Sridhar, Univ. Of Arizona

A PROTOTYPE OXYGEN CRACKER (in gold foil) sits atop a lunar rover prototype in Moscow. Engineers at the University of Arizona remotely controlled the rover to collect samples for the cracker. A working lander/cracker combination might fly later this decade. Shown in the photo is UA graduate student Scott Miller, whose team designed an engineering model of the oxygen cracker and integrated it with the rover in just four months.



Michael Carroll

A RUSSIAN-MADE "DROP ZOND" probe detaches from a Pluto Fast Flyby spacecraft. Before it crashes into the planet, the probe will return data on Pluto's tenuous atmosphere and photos of its surface.

United States, Russia Consider Pluto Mission

Major changes are imminent on the planet Pluto, the most remote known world in our solar system. Because of its eccentric orbit, Pluto is arcing away from the Sun. Plummeting temperatures will soon cause the planet's tenuous atmosphere to condense onto the surface, obscuring some of its surface features with ice by 2010. "If we don't move quickly, the next chance to observe Pluto's atmosphere or its surface won't come for another two and a half centuries," says Jet Propulsion Laboratory planetary scientist Rich Terrile.

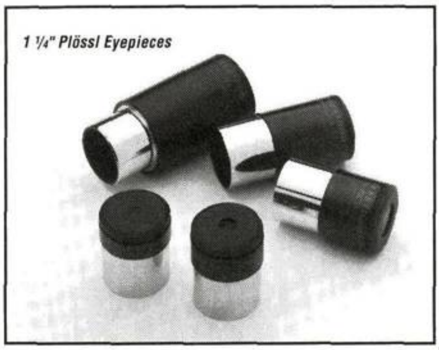
Terrile is part of a team of scientists and engineers working on a proposal to send spacecraft to Pluto before its atmospheric collapse. They are planning an economical, streamlined mission known as the Pluto Fast Flyby, which sends two spacecraft past Pluto in 2004 and 2006 (See "Pluto and Charon: At the Edge of Night," January 1994). The twin spacecraft are to fly14 months apart to observe opposite faces of Pluto and its moon, Charon. The team is looking into a new way to lower the price tag: a collaboration with Russia.

Pluto project manager Robert Staehle explains that the most financially significant Russian contribution would be two Proton launch vehicles. The massive, highly reliable Protons are the world's most inexpensive boosters in their class. Another Russian contribution will increase the science bonanza from Pluto: two "drop Zond" probes to collect data about Pluto's atmosphere and take close-up images of its surface before impact. Each PFF spacecraft would carry a probe. Information from the drop Zonds would be relayed back to Earth through the flyby spacecraft after they sail through the Pluto-Charon system. — *Michael Carroll*

CELESTRON®

200mm (7.9") f/4 NEWTONIAN TELESCOPE GP-C200

An incredibly fast f/4 Newtonian with superb optical quality. The focal length of 800mm is packed in a tube that weighs just 13 pounds and is 28 inches long. The mirrors are multi-coated. The optical tube is mounted on the highly touted GP mount. The standard accessories include a 6x30 finderscope and 12mm ocular.


1 ¼" Plössl Eyepieces

PLÖSSL EYEPIECES

Plössl quality eyepieces (the market's best value) are now available at affordable prices. All units are **multi-coated** for enhanced contrast. A complete series of **both .96" and 1¼" sizes** are offered. Celestron is the first to offer .96" eyepieces of superior design.

Focal Length	Apparent Field	Eye Relief	Sizes
7.5mm	52°	5mm	.96", 1¼"
10mm	52°	6.5mm	.96", 1¼"
17mm	52°	13mm	.96", 1¼"
26mm	50°	22mm	.96", 1¼"
40mm	46°	31mm	1¼"

Ultima Barlow Lens–1.25

ULTIMA EYEPIECES

Celestron's top of the line eyepieces which use a hybrid design of 4 to 7 elements. Features long eye relief and a wide field. **Full** multi-coating on each air-to-glass surface enhances contrast levels. Computer designed to keep the following aberrations to an absolute minimum: spherical, coma, astigmatism, distortion, color, field curvature and spherical of the exit pupil. Inside and all lens edges are blackened to keep out reflected light. The outside is flat black with rubber grips. Included are rubber eyecups for comfort and to keep out extraneous light. Threaded barrels accept thread-in filters. Lens and barrel caps included. Better than any *Plössl!*

FOCAL LENGTH	EYE RELIEF	APPARENT FIELD
5mm – 1.25"	4mm	50°
7.5mm – 1.25"	5mm	51°
12.5mm – 1.25"	9mm	51°
18mm – 1.25"	13mm	51°
24mm – 1.25"	18mm	51°
30mm – 1.25"	21mm	50°
35mm – 1.25"	25mm	49°
42mm – 1.25"	32mm	36°
45mm – 2"	32mm	50°
60mm – 2"	39mm	45°
80mm – 2"	50mm	34°

Ultima Eyepiece Series

ZOOM EYEPIECE

A deluxe zoom eyepiece 6.5 to 18mm – 1.25" was recently designed and has become the finest zoom ever offered for medium to high powered observing. This eyepiece is multi-coated and extremely lightweight (5 oz.).

Deluxe Zoom Eyepiece – 1.25"

Tripod – Alt-Az Photo Mount

TRIPOD – ALT-AZ PHOTO MOUNT

This tripod mount serves as a super heavy duty photo tripod for *cameras with large telephoto lenses, spotting scopes or binoculars.* This unit can also be used for small telescope owners who want to upgrade their mounts. It comes with two slow motion cables, adjustable wood tripod and with a ¼ x 20 photo head.

BARLOW LENSES – THE BEST!

Celestron offers an assortment of Barlow Lenses that will double the magnifying power of your oculars by increasing their effective focal length.

Barlow Lenses mount into your telescope's Visual Back or star diagonal. The new premium quality achromatic Barlow Lenses (1.25" and .96") are **fully** multi-coated and of the short design (under 3"). The .96" weighs just 2 oz. and the 1.25" weighs 4 oz.! The clear aperture is 27mm on the 1.25" model and 21mm on the .96" unit.

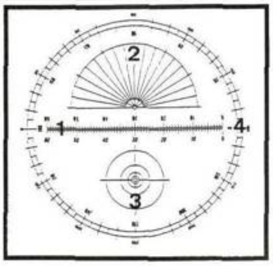
The new Ultima Series Barlow (2X – 1.25") is an air-spaced, three-element apochromatic design with a 27mm clear aperture. It is a super high quality design and **fully** multi-coated. It is amazingly short (2.75") and weighs just 5 oz.

CELESTRON®

MICRO GUIDE EYEPIECE
The finest in the world!

This multi-function guiding eyepiece features a laser-etched reticle with built-in cordless illuminator. The eyepiece is a multi-coated 12.5mm Abbe Orthoscopic. Usage possibilities include: direct guiding on stars outside the center of the field of view, greatly improved off-axis guiding capturing much fainter, sharply focused guide stars without reducing the limiting magnitude, measure position angles and separation of double stars.

The Micro Guide Eyepiece *is totally free of internal reflections and with sufficient eye relief that the reticle* can easily be viewed even with eyeglasses. Its finely laser etched micrometer scale has graduations 50 microns apart and 15 microns wide. It includes: eyepiece, built-in cordless battery holder with adjustable brightness control, batteries, instructions.

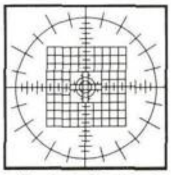


Micro Guide Reticle

Micro Guide Eyepiece

6mm ILLUMINATED RETICLE OCULAR
The second finest in the world!

This Orthoscopic guiding eyepiece has a laser-etched reticle with concentric guiding circles similar to that of the Micro Guide Eyepiece plus conventional cross hairs. The central square is the smallest and most sensitive for guiding in the industry. With *the 6mm ocular, the reticle can be moved about without moving* the eyepiece, making the acquisition of a guide star easier. At 6mm, the higher power provides greater guiding accuracy. Features include: an illuminated reticle and adjustable brightness control. Batteries are included.


6mm Illuminated Reticle Ocular

6mm Illuminated Reticle Pattern

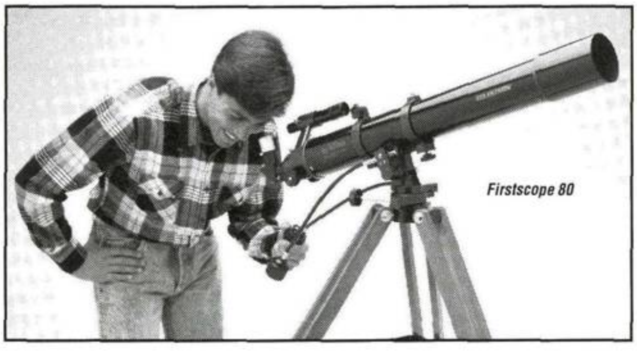
FIRSTSCOPE 80

The Firstscope 80 is an ideal first telescope (80mm aperture) for the more serious beginning astronomer or terrestrial observer. With 131 times the light gathering power of the naked eye, the FS-80 provides 78% brighter images than 60mm telescopes.

Its easy-to-use altazimuth mount includes slow-motion controls in both axes with flex cables *allowing quick and easy pointing and tracking.* The supplied attractive and study wood tripod is adjustable in height.

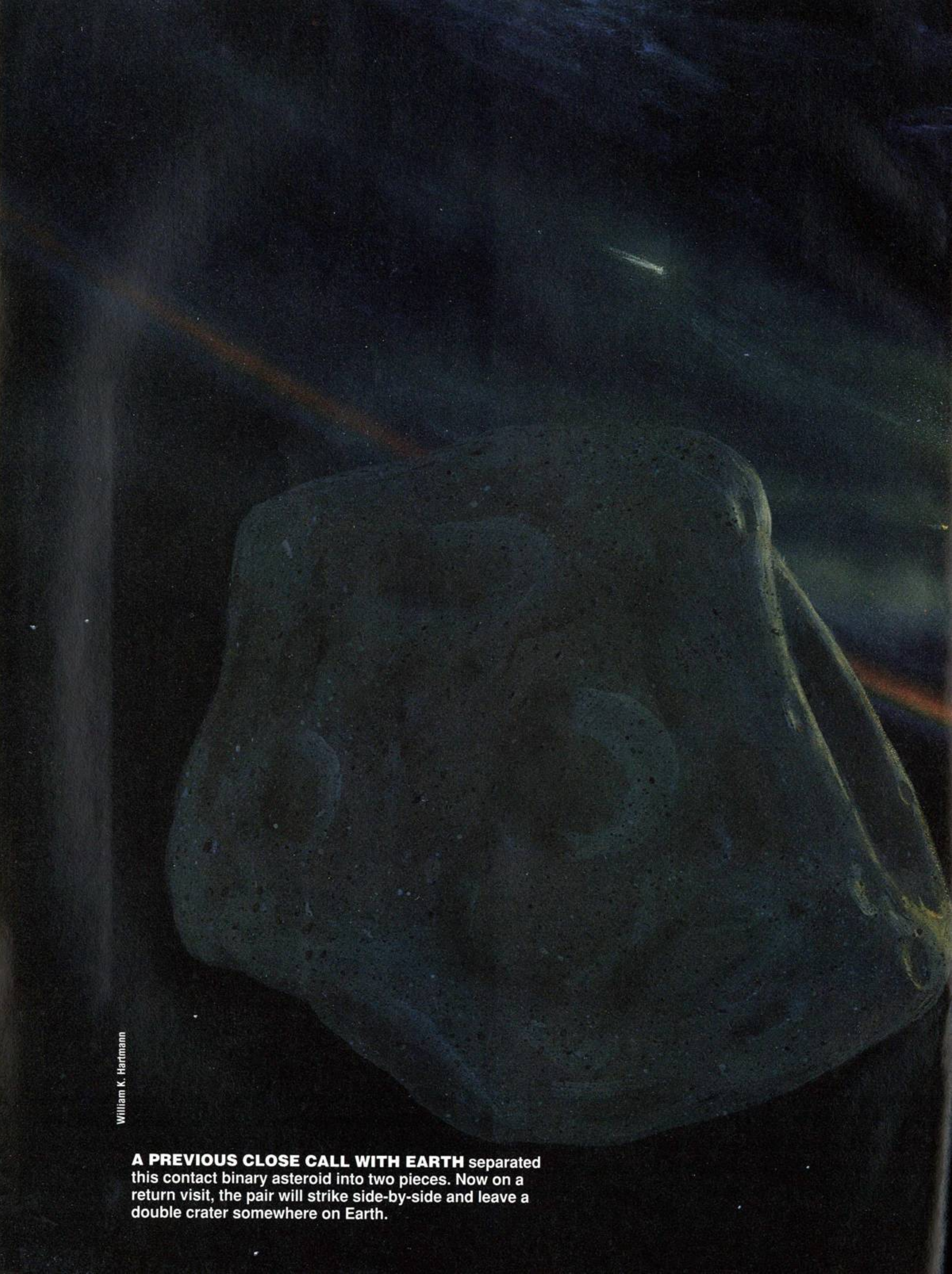
The premium built optics are made in Japan to rigid standards. The objective is an air-space achromat designed to yield the finest images available in this class of instrument. The optical tube is made of aluminum and the accompanying accessories are made of glass *and metal to ensure* excellent image quality.

For astronomy you can enjoy breathtaking views of the Moon, Saturn with its ring structure, Jupiter and its belts and hundreds of deep-sky objects including galaxies, nebulae and star clusters. For terrestrial use, enjoy vistas from view homes or take your instrument out in the field to take advantage of our natural environment up close.


Firstscope 80

CELESTRON® *LIGHT YEARS AHEAD OF THE COMPETITION*

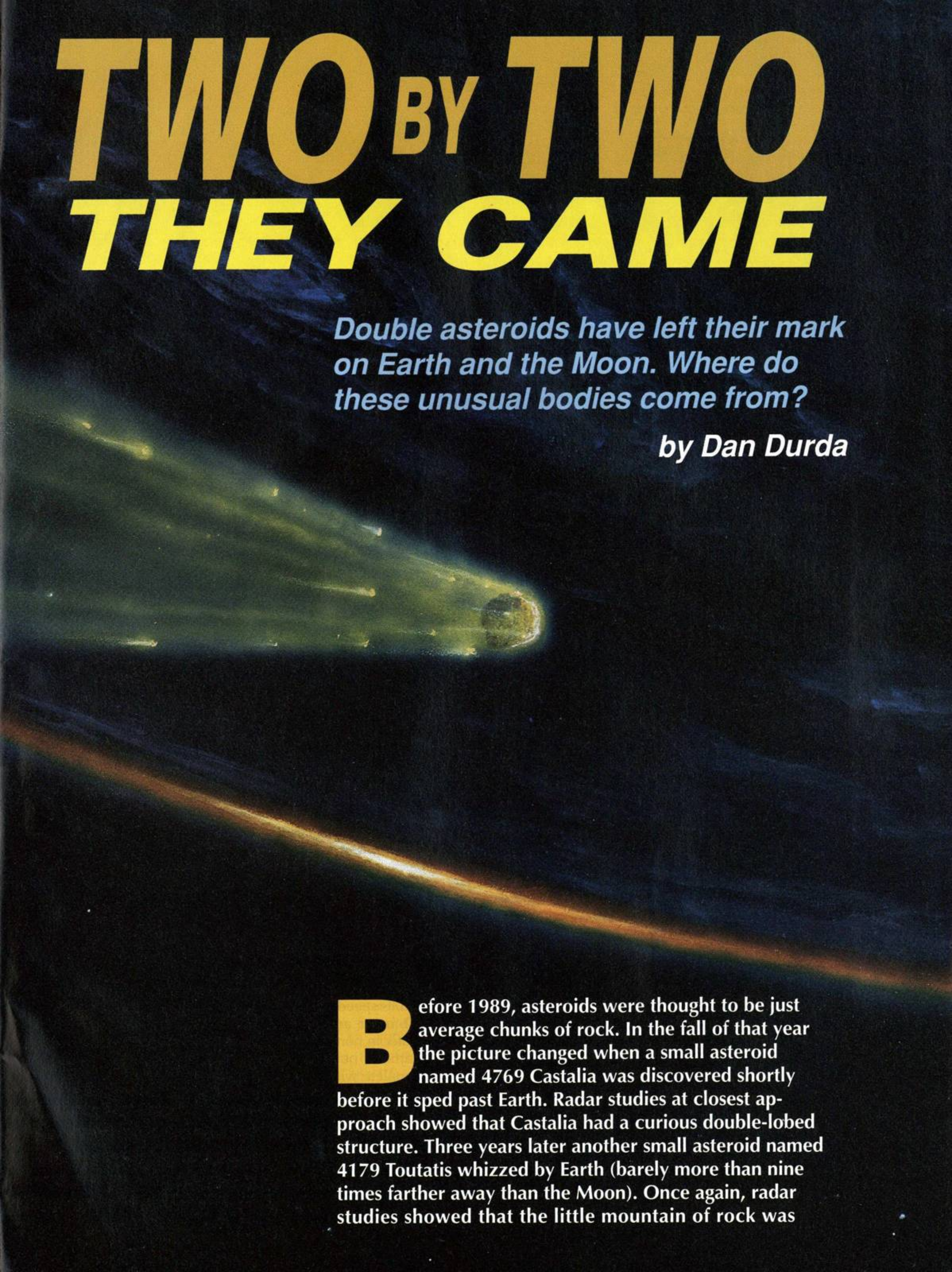
Celestron International • 2835 Columbia Street • Torrance, CA 90503
(310) 328-9560 • FAX (310) 212-5835



William K. Hartmann

A PREVIOUS CLOSE CALL WITH EARTH separated this contact binary asteroid into two pieces. Now on a return visit, the pair will strike side-by-side and leave a double crater somewhere on Earth.

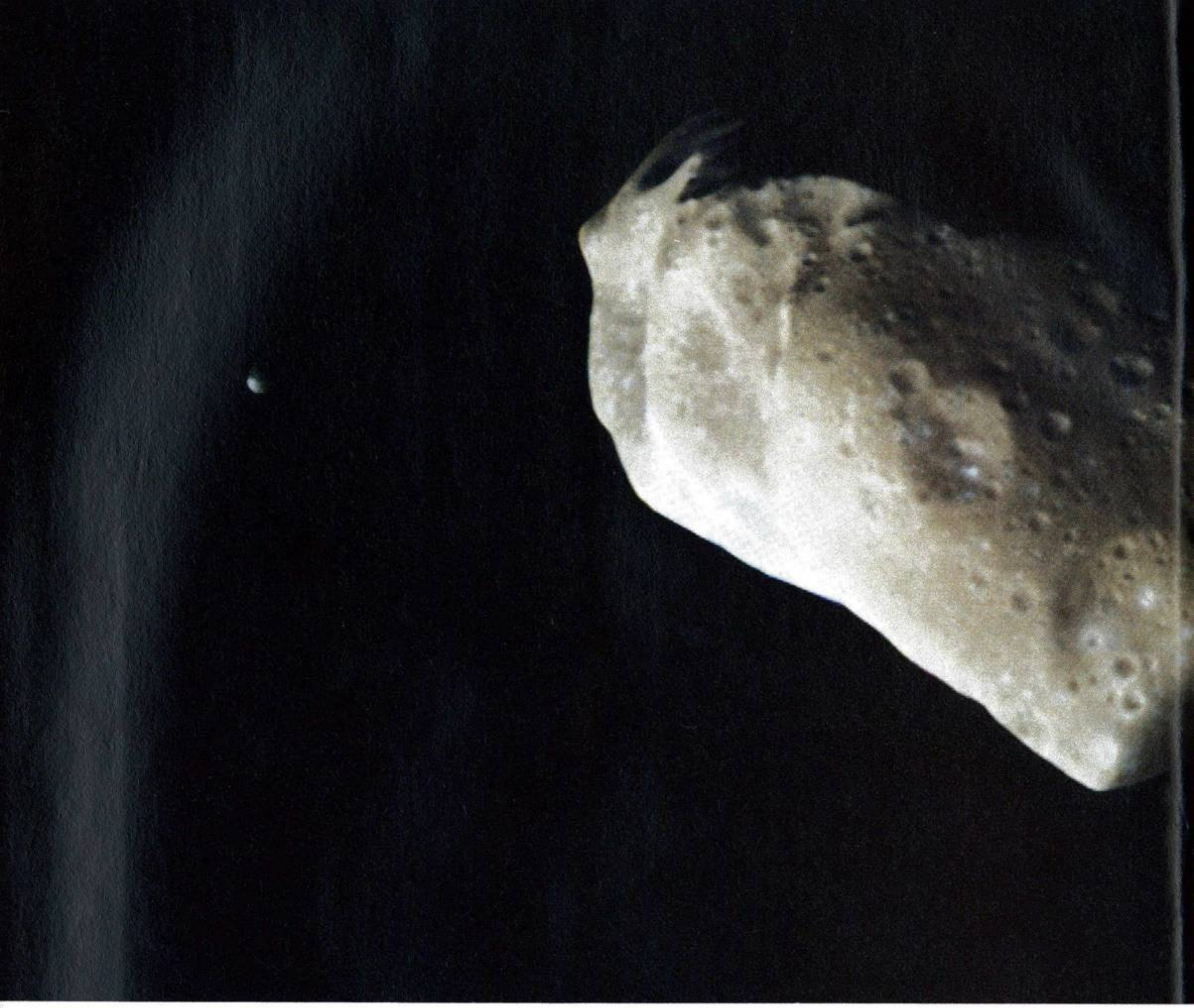
TWO BY TWO THEY CAME



Double asteroids have left their mark on Earth and the Moon. Where do these unusual bodies come from?

by Dan Durda

Before 1989, asteroids were thought to be just average chunks of rock. In the fall of that year the picture changed when a small asteroid named 4769 Castalia was discovered shortly before it sped past Earth. Radar studies at closest approach showed that Castalia had a curious double-lobed structure. Three years later another small asteroid named 4179 Toutatis whizzed by Earth (barely more than nine times farther away than the Moon). Once again, radar studies showed that the little mountain of rock was



really two small asteroids nestled tightly against each other. In 1993 the spacecraft Galileo imaged 243 Ida, an asteroid orbiting the Sun in the main belt of asteroids between Mars and Jupiter. The pictures revealed that Ida was no single body; it had a tiny moon, since named Dactyl, orbiting at a distance of 100 kilometers.

While the notion of double asteroids like Ida may seem startling, the idea is not new. But until recently evidence was scanty and these objects received only limited attention from planetary scientists. But now that astronomers have powerful radar techniques and flyby spacecraft, they are finding that double asteroids may be far more common than ever realized.

How many of these things are out there? The answer may lie in the traces of their demise on planets like Earth.

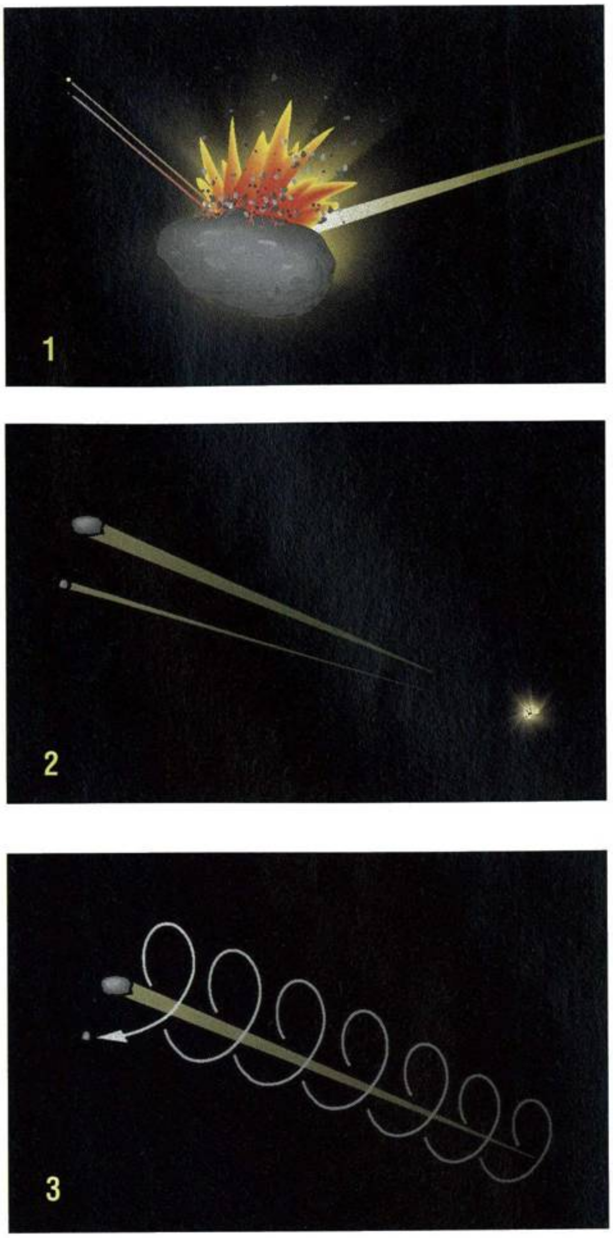
Tag-team Battering

Chicken Little got it basically right — and the evidence lies scattered all through the solar system, including the surface of Earth. Some 200 impact craters mark every continent except Antarctica and show that we did not escape the same cosmic bombardment that scars the Moon's surface. In fact, because of its larger size and stronger gravity, Earth experienced a greater cosmic barrage than that suffered by the Moon. Only the action of wind and water, mountain building and plate tectonics, has masked Earth's record of these cataclysms.

When a small asteroid strikes the surface of any planet at 20 to 60 kilometers per second, the tremendous energy of its motion excavates a bowl-shaped crater many times the size of the asteroid itself. The size of the crater depends on the size of the asteroid and its speed. A 30-meter asteroid will create a crater a kilometer across, like the famous Barringer Meteor Crater in northern Arizona. But asteroids about 1 km in diameter punch out craters tens of kilometers wide, complete with structures like central peaks and ringed walls. In all cases the crater is circular, whether the object comes straight down or from any but the most oblique angles. Single craters like these are a common sight throughout the solar system.

On Earth and the Moon are scars left not only by impacts from single asteroids and comets, but fascinating doublet craters whose form suggests the impact of two projectiles. The lunar crater Bessarion B in Oceanus

NASA/JPL



ASTRONOMY: Lee Vande Visse

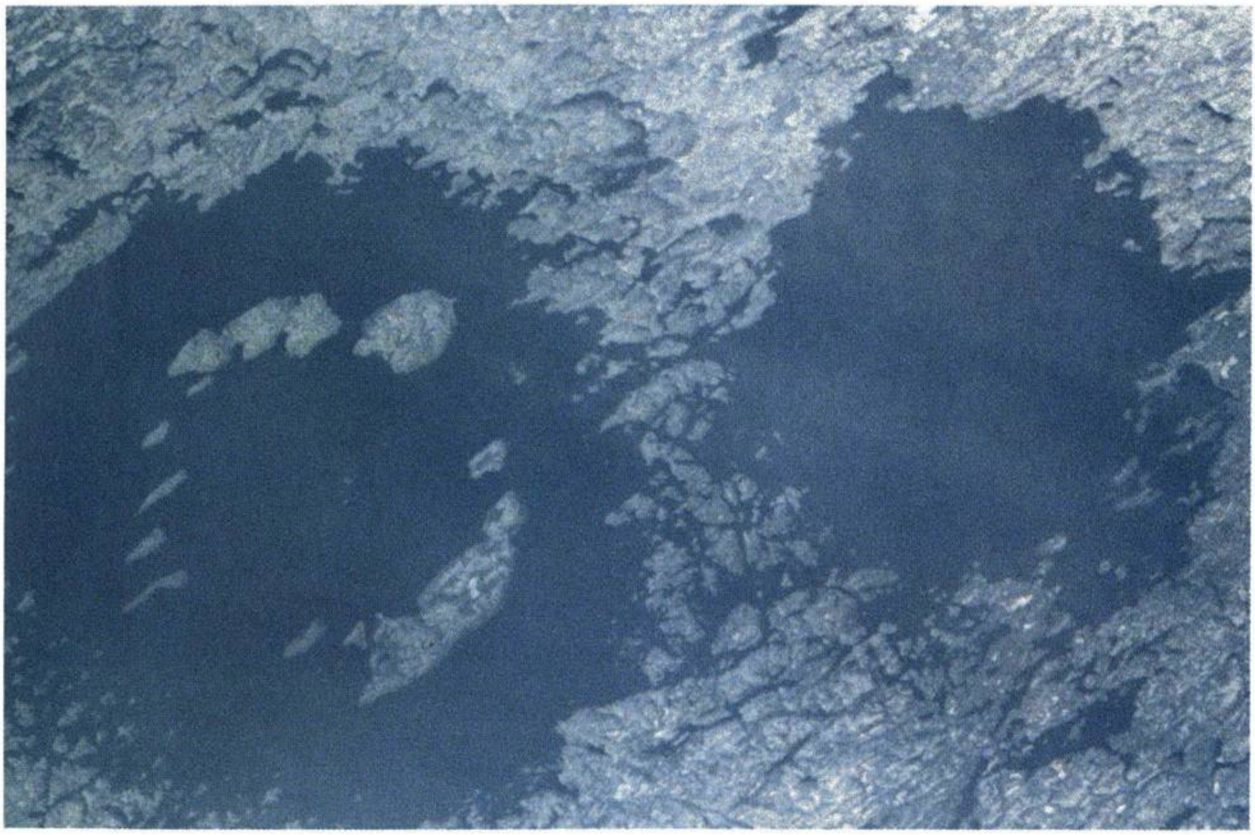
IDA'S MOON DACTYL PUT THE HEAT on astronomers to explain how double asteroids form. Present theory says that millions of years ago two large asteroids collided (1) in the main belt, sending fragments in all directions. As debris fled the scene, by chance some pieces left on nearly identical paths (2). Over time, mutual gravity bound the two fragments into an orbital pair (3). In other cases, some duos gently nestled against one another to form dumbbell-shaped, contact binary asteroids.

Procellarum is a good example (see page 35). Located about halfway between Aristarchus and Kepler, the larger crater of the doublet is some 12 km across. Providing evidence that both impacting bodies struck simultaneously is a septum, or ridge, of ejecta squeezed up between the craters during the violent instant of impact. Another famous crater pair, Messier and Messier A in Mare Fecunditatis, probably came from a pair of bodies traveling low and from the east.

On Earth at least three of the 28 largest well-preserved craters are doublets. The 24-km-diameter Ries crater in Germany and its sibling, Steinheim, found 46 km to the southwest, were formed nearly 15 million years ago. The Kamensk and Gusev craters, found in Russia, date from 65 million years ago. But the Clearwater Lakes of northern Quebec present the most striking example of double craters on Earth (see page 34). They formed when two asteroids of the same size slammed into the Canadian shield east of Hudson Bay some 290 million years ago. All told, about 10 percent of the large craters on Earth are doublets, which points up a very interesting clue about near-Earth asteroids: A sizable percentage of them must be double.

Finding the Culprits

It was only a matter of time before astronomers discovered a genuine double asteroid. In autumn 1989 Steven Ostro of the Jet Propulsion Laboratory beamed radio waves from the large Arecibo antenna in Puerto Rico toward the newly discovered asteroid 1989 PB (now 4769 Castalia). He used the echoes to assemble fuzzy images of the 1.5-km asteroid (see "Radar Reveals a Double Asteroid," April 1990). Processing of the signals led Ostro to conclude that Castalia was two big rocks that touch — a contact binary asteroid.



NASA/Shuttle frame 61A-35-086

THE EFFECTS OF WIND AND WATER haven't yet erased the Clear Lake twin craters of northern Quebec. These formed some 290 million years ago when a double asteroid impacted.

Then in December 1992, the asteroid 4179 Toutatis made a close passage by Earth. By now, improvements at Arecibo and in Ostro's technique let him obtain striking images of the 3-km-diameter asteroid (see AstroNews, March 1993). Only the second near-Earth asteroid to be imaged, Toutatis *also* turned out to be a contact binary, with a large 2.7-km lobe and smaller 1.3-km one.

And more double asteroids are turning up.

Radar observations of near-Earth asteroids 1627 Ivar and 1986 DA, as well as the large main-belt asteroid 216 Kleopatra, show signs of these bodies being dumbbell-shaped. Several other Earth-approaching asteroids, such as 433 Eros and 1620 Geographos, display light curves that vary greatly in brightness, suggesting they are highly elongated or possibly double.

Where did all these double asteroids come from? Perhaps from the same place as the little moon of Ida, Dactyl, which was discovered last spring in images taken by the Galileo spacecraft in August 1993.

Some astronomers see Dactyl not as Ida's daughter, but rather a little sister, born from the same debris cloud as Ida. Ida itself belongs to the Koronis family of asteroids, a group of a few hundred asteroids sharing similar orbital characteristics with 158 Koronis. Planetary scientists believe the family formed when the Koronis parent asteroid was fractured in a major collision with another asteroid. (The Koronis family is but one of many asteroid families; see "All in the Family," February 1993.) After the collision, debris spread out into individual orbits around the Sun very close to the orbit of the original parent. A whole family of asteroids formed from this debris, with some asteroids forming pairs.

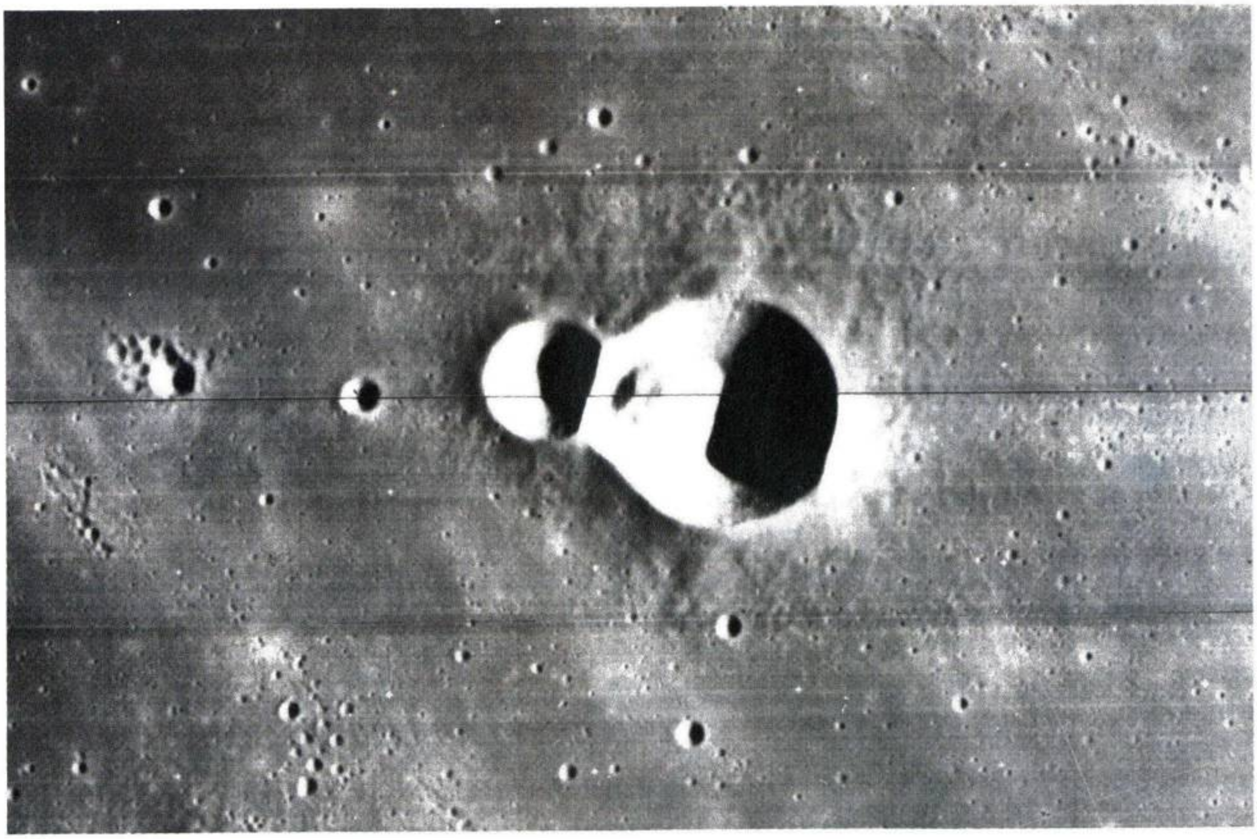
But how? What mechanism creates asteroid pairs? William Hartmann of Tucson's Planetary Science Institute suggests that as fragments blew clear of the catastrophic collision, by chance some moved on nearly identical paths. As time passed, the fragments' feeble gravity bound them into orbital pairs. In this scenario, Dactyl formed at the same time as Ida and from the same parent material, which explains the tiny moon's similarity in color to Ida and why it was still near Ida.

Hartmann's idea also explains contact binary asteroids. He suggests that instead of winding up in orbit around each other, some fragments could collide gently. Rather than hitting hard and fragmenting, the pieces would slowly crunch together to form a big, dumbbell-shaped object with two components.

Computer modeling that I have done indicates that both contact binaries and asteroid moons can indeed form in this way. The model takes a 110-km parent asteroid and shatters it into thousands of pieces. When the debris scatters, I find that there's a better than 50 percent chance at least one of the largest fragments will eventually attract a moon. The moonlet remains in orbit around the larger asteroid (as we see with Dactyl) or, if its orbit isn't stable, collides gently to form a contact binary like Toutatis and Castalia.

Double Craters, Round Two

With hard evidence that double asteroids exist, planetary geologists are now re-examining how double craters formed on the Earth and Moon. In 1991 Jay Melosh and John Stansberry of the University of Arizona's Lunar and Planetary Laboratory confronted a vexing problem presented by double craters observed on Earth. Many show a wider separation than would be possible if a contact binary caused them. At first Melosh and



NASA/Lunar Orbiter IV frame H144

DOUBLE CRATERS ON THE MOON were once thought to be all volcanic. Scientists now think that some, such as Bessarion B in Oceanus Procellarum, were created when a large asteroid and a smaller companion struck the Moon together.

Stansberry guessed that tidal stresses separated the contact binary enough to produce two independent craters on impact. Careful calculations, however, indicated that the tidal effects of Earth weren't strong enough and, moreover, the approach speed of the asteroids was too fast to produce the required separation. Thus they concluded that, as it stood, contact binaries could not account for double craters; 10 to 20 percent of near-Earth asteroids — too many, in other words — had to be orbiting pairs in order get the necessary separation between the impactors to explain the observed craters.

Then recently Italian astronomer Paolo Farinella of the Università di Pisa rescued the contact binary explanation. Maybe, he said, more than one pass by the Earth took place. According to Farinella's work, tidal forces during the first close encounter were enough just to "pre-separate" the contact binary, so that the next time the asteroid encountered Earth, tidal forces opened the separation a little more just before impact. That provided the distance required to produce the doublet craters we see.

With assistance from Melosh, William Bottke of the Lunar and Planetary Laboratory is now testing this idea. They have combined the original tidal model with an orbital evolution one that follows the paths of a model contact binary asteroid as it makes multiple encounters with Earth. Their calculations indicate that the multiple encounters split contact binaries, which then impact Earth to create double craters we see.

Nature herself arranged for a demonstration of tidal splitting when a close pass by Jupiter crumbled Comet Shoemaker-Levy 9 into two dozen pieces before it struck the giant planet last July. Shoemaker-Levy's breakup drove Melosh and Paul Schenk of Houston's Lunar and Planetary Institute to scrutinize Voyager images of Jupiter's Galilean satellites for evidence of similar events in the past. They found several chains of impact craters that suggest other comets shared Shoemaker-Levy's fate, striking Jupiter's moons shortly after a close encounter with the giant planet. (See AstroNews, February 1994.)

And there may be signs of this "string of pearls" effect on the Moon in the form of crater chains. Robert Wichman and Charles Wood of the University of North Dakota and, independently, Ewen Whitaker of the Lunar and Planetary Laboratory and Melosh proposed that the Davy crater chain in Mare Nubium formed when a close encounter with Earth split a comet or weak asteroid into a dozen or so pieces that later impacted the Moon. (See AstroNews, September 1994.) Another larger chain of craters near Abulfeda may record yet another chain of impacts on the Moon.

Crater chains and pairs bear silent testimony to the varied dynamics that continue to shape our solar system. Until recently, two pieces of the double asteroid puzzle — double asteroids and the forces that split them to create multiple craters — remained mostly in the realm of theory. Now that scientists have found bona fide asteroid duos and evidence of events that form multiple impacts on planets, the solar system has become a more exciting place to live. □

Dan Durda studies asteroids at the University of Arizona's Lunar and Planetary Laboratory. His last ASTRONOMY *article was "All in the Family" which appeared in the February 1993 issue.*

ORION
TELESCOPE CENTER

THE WORLD'S LARGEST CATALOG
OF TELESCOPES, BINOCULARS & ACCESSORIES
FOR AMATEUR ASTRONOMERS

Since 1975

America's #1 Source of Superior Telescopes, Binoculars & Accessories

Fast SAME DAY shipping on phone orders received by Noon Pacific Time. Safe *Guaranteed* shipping to anywhere in the USA and Canada!

Call Toll-Free Today For Your Free 100 Page Color Catalog!

Packed with a huge selection of quality telescopes, binoculars and accessories, all at low discount prices! Hundreds of exclusive items you won't find anywhere else.

Only a small selection of our products are in this ad—be sure you have our catalog!

Call Toll-Free 800-447-1001

Visit One Of Our Three Unique Retail Stores

America's biggest & best selection of telescopes, binoculars & accessories. Now 3 convenient Northern California locations!

San Francisco
1 block from Marina Safeway
3609 Buchanan St., at Bay
415/931-9966

Silicon Valley–San Jose–Cupertino
10555 S. DeAnza Blvd., at McClellan
From Hwy 280 take Cupertino exit, south 1.5 miles on DeAnza, from Los Gatos take Hwy 9 to Saratoga-Sunnyvale Rd.
408/255-8770

Monterey Bay–Santa Cruz
2450 17th Ave., West Marine Building,
From Hwy 1, take Soquel Drive exit, 1/2 block from the freeway at Soquel Avenue
408/464-0465

Some prices in retail stores may vary.

MONEY-BACK GUARANTEE

If you are not completely satisfied with your purchase from Orion, for any reason,

100% Satisfaction

just return it in new condition within 30 days after delivery for a prompt refund.

Celestron Ultima 2000 —
The new leader in High Performance computer driven Schmidt-Cassegrain telescopes!

Orion is the place to call for the best price and fastest delivery on Celestron's hottest new telescope! At last, a SC telescope that moves quickly and quietly from subject to subject. Much faster, much lighter weight, much easier to use than any other telescope! Revolutionary new mount with roller drive...NO worm gear periodic error! Fantastic easy-to-use controller with huge 10,000 subject database. Completely powered by penlight batteries! Complete information in our new catalog!

CALL for our low, low price!

Dozens More Telescopes in Our 100 Page Free Catalog!

Orion® Deep Space Explorer™ Dobsonian Telescopes
The best telescope choice in the universe for beginning amateur astronomers!

Featured in an in-depth article in *Astronomy* magazine (12/93) and in the *Sky & Telescope* article "Choosing a Low-Cost Telescope" (12/93). *(Ask for free reprints.)* Find out what the reviewers have been raving about: the Orion Deep Space Explorer telescopes offer the highest-performing complete optical system available!

Ideal for both beginners and advanced astronomers, these great new scopes offer high performance and lasting value. With their fantastic precision ground and polished reflector optical systems, they are ideal for interplanetary, lunar, and deep space observation.

Compare the features to any other telescope: superb hand-figured optics that out-perform similar sized and even larger-sized competitive scopes; a first-rate fully coated Sirius Plössl eyepiece; a quality machined aluminum low-profile helical focuser; low diffraction stay-put secondary support, providing less diffraction than four-vane "spiders" on competitive models; unique counterbalance mounting point; acclaimed smooth-motion Dobsonian mount.

6", 8", 10" and 12.5" Models

Prices Start at $319

Prices include precision helical focuser and 25mm Sirius Plössl eyepiece!

Binoculars for Astronomy

Orion® 8x56 Mini Giants

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects and daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view. Standard model 33 oz. or Rubber Armored for protection from bumps, weighs 37 oz.

Standard Model #9504 **$159** (4.71)
Rubber Armored Model #9627 **$179** (5.07)

50mm Explorer™ Binoculars

High performance large diameter binoculars with BAK-4 prisms and multi-coatings. Great for both astronomy and daytime observation. Comfortable ergonomic body design. Include case and straps.

7x50 #9306 **$124** (4.44)
10x50 #9308 **$129** (4.44)

Orion 50mm UltraView™

The perfect binocular for eye- and sunglass wearers. Extra-long 23mm eye relief and unique rubber pop-down eyepiece guard allows viewing with or without eyeglasses. Fully multi-coated optics provide high light transmission and maximum contrast compared to standard coated types. BAK-4 prisms. Wide 6.5° field of view. Close focus 16'. Weighs 32 oz. Includes case and straps.

10x50 #9351 **$169** (4.95)
7X50 #9357 **$169** (4.95)

Orion 50mm Vista™

Superb for long distance nature observation and astronomy. The image quality will amaze you even when compared to much higher priced binoculars. Fully multi-coated optics provide high-fidelity true color images without ghosting or other aberrations. Long 16mm eye relief and roll-back eyecups for eyeglass wearers. BAK-4 prisms. Weighs just 28 oz. Includes deluxe hard carrying case, rain shield, lens caps, and straps.

10x50 5.3° field of view #9353 **$219** (5.19)
7X50 6.0° field of view #9355 **$219** (5.19)

Orion® 70mm FMC Giants

The standard for hand-holdable astronomy binoculars. Fully Multi-Coated. 33% lighter, weighs only 58 oz., yet the same brightness and 7mm exit pupil as our 11x80 MC model. Superior 'BCF' body design. Includes: soft rubber eyecaps, tripod mounting adapter, durable hard carrying case, lens caps and straps.

10x70 #9501 **$339** (6.97)
14X70 #9494 **$339** (6.97)

80mm FMC Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest field available. Ideal for deep-space observation under dark skies. Hand-holdable. #9502 **$439** (8.05)

16x80 MC- 45% higher power, excellent for astronomy and daytime observation. Tripod recommended. #9496 **$439** (8.05)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required. #9498 **$439** (8.05)

Orion Standard Series 80mm Giant Binoculars

Made in the same factory as name brand models selling for much more! Fully coated optics with multi-coatings and BAK-4 prisms. Smooth center focus design. Soft rubber fold-back eyecups. Include lens caps, straps, and carrying case.

11x80 model Bright 7.1mm exit pupil, 4.2° field of view #9480 **$299** (7.76)

16x80 model 5mm exit pupil, 3.5° field of view. #9482 **$299** (7.76)

SuperGiant™ 100mm Binos

Gigantic, almost 4" lenses gather 156% of the light of 80mm binoculars. Individual eyepiece focus, fully Multi-Coated optics and BAK-4 prisms. Tripod mounting plate, metal-clad case. Weight 7.5 lbs., height 13.5".

Sale!

14x100 #9495 **$899** (14.00)
25x100 #9497 **$999** (14.00)
Shipped by FedEx only.

Observing Aids

Eyepiece & Accessory Cases

With patented unbreakable latches, die-cut foam inserts. (Inside Dimensions shown)

Small Case (shown) 11"x7"x3" #5951 **$17.95** (2.78)
Medium Case 12.5"x9"x5" #5952 **$26.95** (3.36)
Large Case 16"x11"x5" #5953 **$49.95** (5.19)

Orion® FlexiShield™ Dew Caps

Forms into a tube with Velcro closure, opens flat for storage and travel. Models to fit most telescopes.
8" Celestron/Meade SC #4200 **$44.95** (2.98)

Other sizes available for scopes 3.5" to 14"—See our catalog for details.

Orion® Dew Zapper

Gently replaces lost heat, a sure-fire cure for dew problems.

8" Dew Zappers—fit all Meade & Celestron 8" SCs DC #3503, AC #3504 **$47.95** (2.98)
10" Dew Zappers—fit all Meade 10" SCs DC #3506, AC #3508 **$54.95** (2.98)
11" Dew Zappers—fit all Celestron 11" SCs DC #3510, AC #3512 **$59.95** (2.98)

Scope Saver Telescope Covers

Keep the dust and dew away with these waterproof nylon covers; drawstring closure with cord lock.

8"Model #15130 **$33.95** (2.43)

10"-11" Model Fits Meade 10" and Celestron 11" #15131 **$39.95** (2.43)

Now available for Deep Space Explorers!
Ask about other sizes.

Observer's Chairs

Standard Model—Adjustable height center column and padded seat. #5935 **$42.95** (4.70)
Deluxe Model—Built for professional musicians. Extra heavy duty. #5934 **$94.50** (8.02)

Night Vision Flashlights

An essential accessory for astronomers. Choose from our wide selection.

Nitewriter Pen #5709	**$8.95**	(1.79)
Hands-Free Flex Light #5707	**$17.95**	(2.43)
Starlite LED Flashlight #5714	**$24.95**	(2.43)
Celestron LED Flashlight #5720	**$21.95**	(2.43)

Filters

Glass Solar Filters

High-quality optical glass filters, for superb images of the sun with your telescope. Triple-coated with advanced scratch-resistant stainless steel alloy. Great for both visual and photographic use. Slide fits over the front of your telescope.

For 8" SCs #7713 **$144** (4.05)
For 10" SCs #7715 **$162** (4.05)

NEW! *Solar glass filters for Deep Space Explorer reflectors. Many other sizes available—see our free catalog for details.*

Moon Filters

Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.

.965" #5664, 1.25" #5662 **$15.95** (2.43)

Color Eyepiece Filters

Made from absolutely the highest quality photographic-grade precision-ground optical glass, anti-reflection coated. Ideal for contrast-enhancing planetary and lunar observations and photography with any telescope. The black anodized, machined aluminum cells thread into any standard eyepieces, or into our universal camera adapters.

.965" Basic Set of 4 Filters #80A Blue, #58 Green, #25 Red, #15 Yellow. #5510 **$49.95 set** (2.98)

1.25" Basic Set of 4 *#80A Blue, #58 Green, #25 Red, #15 Yellow.* #5514
1.25" Expansion Set of 4 *#21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.* #5516
1.25" Advanced Set of 4 *#8 Light Yellow, #23A Light Red, #38A Deep Blue, #56 Light Green.* #5570
$54.95 each set (2.98)

Deluxe Set of 8 Filters for 1.25" Includes all the filters in our basic and expansion filter sets. #5517 **$99.95 set** (3.45)

Full Set of 12 Filters for 1.25" Includes Basic Set, Expansion Set, Advanced Set. #5575 **$144 set** (3.67)

2" Set of 4 Includes #80A Blue, #58 Green, #21 Orange and #12 Yellow. #5513 **$89.95 set** (2.98)

Individual .965", 1.25" & 2" Filters- Many colors available, see our catalog for details.

SkyGlow™ Light Pollution Filters

The finest available, SkyGlow™ filters from Orion make detailed deep-sky observing possible from light polluted city and suburban locations. Sophisticated multi-layer technology actually absorbs light pollution! Greater blocking and higher transmission than competitive models. See catalog for details..

SkyGlow UltraBlock Filters–
Visual Only

For severely light polluted areas and faint nebulae.

1.25" UltraBlock Filter–fits 1.25" eyepieces. #5654 **$99.95** (3.45)
2" UltraBlock Filter–fits 2" eyepieces. #5657 **$149** (3.67)
.965" UltraBlock Filter–fits .965" eyepieces. #5655 **$79.95** (2.98)
SC UltraBlock Filter–fits rear cell of Meade & Celestron SC scopes. #5656 **$149** (3.67)

SkyGlow Broadband Filters—Photographic and Visual

For use in slightly to moderately light polluted areas.

1.25" Broadband Filter–fits 1.25" eyepieces. #5660 **$79.95** (3.45)
SC Broadband Filter–fits rear cell of Meade & Celestron SC scopes. #5658 **$99.95** (3.45)
52mm Broadband Filter–For 52mm camera lenses. (Adapter rings available for other diameters.) #5668 **$87.50** (3.45)
2" Broadband Filter–fits 2" eyepieces. #5659 **$119** (3.45)
.965" Broadband Filter–fits .965" eyepieces. #5661 **$49.95** (2.98)

Accessories

Call Toll-Free for Our Huge 100 Page Catalog and See Even More!
Orion Accessories are absolutely guaranteed to be the finest quality available. Compare them side-by-side with "famous name" products! We buy direct from many of the same sources, always specify the highest quality and pass along the savings to you! 100% satisfaction guaranteed!

Universal Camera Adapters

For prime focus or eyepiece projection astrophotography.
.965" #5268 **$27.95** (2.98)
1.25" #5264 **$29.95** (2.98)
Hybrid 1.25"/.965" #8782 **$29.95** (2.98)

Variable Power Camera Adapter

Allows variable projection distances during eyepiece projection photography. For 1.25" eyepiece holders.
#5262 **$39.95** (2.98)

Orion Slow Motion Adapter

Attaches to your photo tripod pan head. 2 slow motion control knobs to make precision adjustments in altitude and altazimuth. Very handy for tracking planets, the Moon, etc. with refractor telescopes and small spotting scopes. Attaches with a standard 1/4-20 thread.
#7012 **$64.95** (2.98)

Extension Cable for Slow Motion Control

12 3/4" flexible cable, for tracking at high powers. Buy 2, one for each axis.
#5014 **$19.95 ea.** (2.43)

Tele-Extenders for SC Scopes

For high powered photography with your Meade, Celestron 4", 8", 10", 11", 14" Schmidt-Cassegrain.
Standard Tele-Extender #5125 **$29.95** (2.98)
Variable Tele-Extender #5127 **$39.95** (2.98)

T-Adapters for SC and MAK

Threads to rear cell of telescope, requires t-ring for your camera model. *for SC* #5116 **$26.50** (2.98)
for C-90 #7115 **$34.95** (2.98)

T-Rings for all 35mm Cameras

Available for many different camera types, call toll-free or see our catalog for your particular model.

45° Erect Image Diagonal Prisms

See the world as it really is with Orion's 45° erect image diagonal. Ideal for all refractors and compound telescopes used for terrestrial viewing.
1.25" Diagonal #8790
.965" Diagonal #8791
Hybrid 1.25"/.965" Diagonal #8792
$44.95 (3.45)

90° Star Diagonal Prisms

Orion's multi-coated diagonals let you view at a right angle from the direction your telescope is pointing. The image is backward. Ideal for refractors and Schmidt-Cassegrains used for astronomical viewing.
1.25" Star Diagonal #8763 **$49.95** (2.98)
.965" Star Diagonal #8761 **$29.95** (2.98)
Hybrid 1.25"/.965" Star Diagonal #14008 **$33.95** (2.98)

Orion Ultra™ 2" Diagonals

Your SC or refractor deserves the finest. Both models are the finest optical quality and use the best coatings available.
2" Prism Diagonal–Absolutely the finest quality multi-coated 2" prism for highest light transmission.
For refractors #8770
For Schmidt-Cass. #8771 **$219** (4.71)
2" Mirror Diagonal– Affordable, high-quality first-surface optical flat star diagonal.
For Schmidt-Cass. #8772 **$99.95** (3.45)
For refractors #8773 **$109** (3.45)

Sky Wizard™

SAVE $50 On Any Sky Wizard when purchased with any telescope installation package!

Electronic Finder & Sky Catalog

Let Sky Wizard do the work, while you relax and have fun observing!

- Find any celestial subject in 15 seconds!
- One minute setup — no polar alignment or levelling.
- Observe hundreds of objects in a few hours!
- For ANY telescope, with or without a motor drive. *Even altazimuth or Dobsonian scopes!*
- Digital display of celestial coordinates (RA & Dec).
- Built-in electronic sky catalog — find subjects by their common catalog name, not their coordinates. Complete with object descriptions.
- Powered by a single 9v battery. Weighs just 6 oz!

Sky Wizard Model 1
Includes the Messier Deep Space Catalog of 110 objects, 28 bright stars, and the planets. #7801 **$199** (4.11)

Sky Wizard Model 2
Huge 2100+ object database, plus a user catalog to store 27 objects of your choice. #7802 **$319** (4.44)

Sky Wizard Model 3
Gigantic 10,000 object database, expanded subject descriptions, RS-232 port. #7803 **$469** (6.78)

Complete system requires Sky Wizard Model 1, 2 or 3 and a telescope installation package, sold separately.

Installation Packages
Includes 2 encoders, all required mounting hardware and brackets, connecting cables, and complete illustrated instructions.
Installation packages are available for most telescope models. Call for details.
starting at **$177** (5.29)

Encoders and cables also available separately for custom installations. Call for details.

Orion Off-Axis Guider

Allows you to observe a guide star during photography. Multi-coated.
#5144 **$74.95** (3.45)

Orion UltraGuider

Wide-range lateral prism adjustment; precision helical focusing; adjustable camera focal plane position.
#5139 **$129** (4.19)

110v Motor Drive for Refractors

Fits Orion equatorial mounts, many others. Plugs into any standard AC outlet.
#17001 **$74.95** (3.95)

12 Amp Hour Porta Pac Battery

Ideal for high power-consuming accessories. With carrying case. Weighs only 10 lbs.
#2354 **$109** (8.97)

Eyepieces

See Our Huge 100 Page Catalog for Many More! Including a Fantastic Selection of Name Brand Eyepieces!
2
3b
3c
3a
5
1
40mm ✧Sirius™ Plössl

1 ✧ *Sirius*™ *Plössl 1.25" Eyepieces*

Fantastic Name-Brand Quality Eyepieces at an Incredible Low Price!

You could pay nearly twice the price for "famous name" Plössl eyepieces, but we don't think you'll be able to tell the difference if you compare them to these fantastic eyepieces!
Sirius Plössls are top-quality, 50° apparent field (43° 40mm) eyepieces with extremely sharp images of impressively high contrast. Ideal for all types of telescopes. The Classic 4-element Plössl design is renowned for its fantastic performance and has become the standard by which all other eyepieces are compared.

The Fully Magnesium fluoride coated optics are mounted in precision black anodized aluminum housings with chrome-plated brass 1.25" barrels for durability and precision fit.

26mm #8732, *17mm* #8734,
10mm #8736, *7.5mm* #8738 **$57.95 ea.** (3.45)
40mm #8730 **$79.95** (3.67)
Case only #5911 **$12.95** (2.19)

SPECIAL OFFER–Buy Two or More and Save!

- *Any 2 .... $10 off (Save $5 ea.)*
- *Any 3 .... $30 off (Save $10 ea.)*
- *Any 4 .... $60 off (Save $15 ea.)*
- *ALL 5 .... $85 off (Save $17 ea.)*

*Bonus—**Free case** with purchase of 2 or more!*

2 Orion 5-Element Ultrascopic™ Eyepieces

With Superb Ultra™ Multi-Coatings!

Made for Orion by Japan's finest lens maker, Ultrascopic eyepieces yield the highest contrast, greatest light transmission and best overall image fidelity obtainable. With a superior 5-element design and Ultra™ Multi-Coatings on *every* surface, they achieve a level of performance "name brand" 4-element models can't match. Wide 52° flat field of view. Removable contoured rubber eyeguard. The 5mm and 3.8mm feature advanced 7-element designs which yield surprisingly long eye relief. Absolutely guaranteed to knock your socks off!

Medium-High Power 5-element
20mm #8566, **15mm** #8568, **10mm** #8570, **7.5mm** #8572 **$89.95 ea.** (3.45)

Wide Field 5-element **25mm** #8564 **$99.95** (3.45)
30mm #8562 **$109** (3.45)
35mm #8560 **$119** (3.45)
***High Power 7-element** —Long Eye Relief*
5mm #8574, **3.8mm** #8576 **$99.95** (3.45)

3 Orion Explorer™ Multi-Coated 1.25" & .965" Eyepieces

These fine quality multi-coated eyepieces offer great performance at Orion's low direct-discount price. Three different optical designs are incorporated to maximize efficiency in the various focal lengths. Black anodized, internally blackened, threaded for filters (except 40mm .965").

b *1.25" Orthoscopic*
5mm #8500, **7mm** #8502, **9mm** #8504, **12.5mm** #8506, **18mm** #8524, **25mm** #8526
$57.95 each (2.98)

c *1.25" Kellner*
6mm #8536, **9mm** #8538, **12mm** #8540, **18mm** #8508, **25mm** #8510, **40mm** #8512
$47.95 each (2.98)

a *.965 Orthoscopic*
5mm #8580, **7mm** #8581, **9mm** #8582, **12.5mm** #8583 **$49.50 each** (2.98)

a *.965 Kellner & Achromatic Huygenien*
K 18mm #8584, **K 25mm** #8585, **AH 40mm** #8586
$37.50 each (2.98)

Illuminated Reticle Eyepieces

A necessity for long exposure astrophotography and very useful for polar alignment.

12.5mm Plössl Illuminated Reticle 1.25"
Illuminator has fully adjustable brightness. Features double crossline reticle. Batteries included.
#8484 **$119** (3.45)

9mm Orthoscopic Illuminated Reticle 1.25"
Adjustable brightness illuminator. 'Bull's-eye within crosshairs' reticle. Needs 2 SR-44 batteries, not included.
#8488 **$129** (3.67))

12mm Kellner Illuminated Reticle 1.25"
Features double crossline reticle and red LED illuminator. Plugs into power panel drive bases.
#8482 **$74.95** (3.45)

12mm Kellner Illuminated Reticle 1.25"
Same as #8482 above except has a wireless illuminator. Needs 2 SR-44 batteries, not included.
#8481 **$99.95** (3.45)

SR-44 Batteries (pkg. of 2) #2360 **$5.95** (1.79)

5 UltraZoom™ 7–21mm

The finest zoom you can buy for your 1.25" telescope. For astronomy or terrestrial observing. 65°-35° field. Fully coated.
#8556 **$179** (3.67)

Barlow Lenses

Orion offers a large selection of barlow lenses, allowing you to double or even triple the power of your eyepieces, maximizing the versatility of your collection. Available in .965", 1.25" and 2" diameters.

Fully Baffled 2x Barlow
Multi-coated, with internal baffling to block transmission of stray light. Premium performance at a remarkable price.
.965" #8740 **$39.95** (2.98)
1.25" #8746 **$46.95** (2.98)
2" #8724 **$89.95** (3.95)

Ultrascopic 2x Fully Multi-Coated Barlow
3-element Ultrascopic lens for superior images and precise color correction. Fully multi-coated optics, black anodized barrel. 1.25 barrel.
#8750 **$64.95** (3.45)

VariPower 2-3x Barlow
Allows you to adjust the magnification factor of the barlow by sliding the internal cell along a calibrated scale. Fully multi-coated optics. 1.25" barrel.
#8748 **$59.95** (3.45)

Shorty Barlows
The short bodies allow extra versatility: provides 2x magnification when the eyepiece is inserted directly and 3x magnification when positioned before the diagonal on a refractor or SC. Will work in all telescopes, including those where longer barlows won't work.
.965" #8710 **$44.95** (2.98)
1.25" #8711 **$54.95** (3.45)

Quality Components for Building or Upgrading

Parabolic Primary Mirrors

Excellent hand-figured parabolic mirrors guaranteed to meet theoretical limits of resolution. Fine polished, coated twice: with Aluminum and Silicon monoxide. Very competitively priced! *See catalog for pricing.*

Standard Primary Mirrors
Made from fine soda-lime plate glass, 1:8 thickness ratio. Guaranteed 1/8 wave. Sizes: 6" f/8, 8" f/6, 10" f/4.5, 12.5" f/6.

Pyrex Low Expansion Mirrors
Made from fine annealed Pyrex brand low expansion glass, 1:8 thickness ratio. Guaranteed 1/10 wave. Available with standard or 94% reflectivity Enhanced Aluminum coatings. Sizes: 6" f/5, 6" f/8, 8" f/6, 10" f/4.5, 10" f/6, 12.5" f/6.

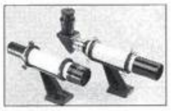
Elliptical Secondary Mirrors

Made from fine annealed Pyrex brand glass, aluminized and SiO overcoated. Guaranteed 1/10 wave accuracy. Available with standard or high reflectivity Enhanced Aluminum coatings. Nine sizes from 1.00 to 4.00" minor axis.
See catalog for pricing.

6x30 Achromatic Finder Scopes

6x30mm—Same unit used on $1000+ "big name" telescopes. With 2-ring metal bracket, fits scopes 6"-12".
#13023 (white) **$49.95** (3.41)

6x30mm Right Angle—90° prism for right-angle viewing. Includes bracket.
#13021 (white) **$74.95** (3.41)



Large Aperture Finder Scopes

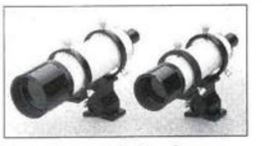
These are high-quality finders at incredibly low prices! Fully coated wide field achromatic optics with adjustable focus. Precision crosshairs. White or black enameled metal tube. (Mounts sold separately.)

8x50mm—2.7x light grasp of 30mm models. Bright 6.25mm exit pupil.
#7090 (white) #7094 (black) **$69.95** (3.41)

8x50mm Illuminated—Wireless illuminator with adjustable brightness.
#7092 (white) #7096 (black) **$99.95** (3.41)

9x60mm — 44% more light grasp than 50mm models.
#7091 (white) #7095 (black) **$99.95** (3.41)

9x60mm Illuminated—Wireless illuminator with adjustable brightness.
#7093 (white) #7097 (black) **$139** (3.41)



Superb Dovetail Aluminum Mounts for 50mm and 60mm Finder Scopes

Instantly install or remove your finder, without tools, without disturbing alignment! Black anodized, fits any scope 6" and over including Celestron & Meade SCs. *(pictured above)*
8x50mm bracket #5040 **$37.50** (2.45)
9x60mm bracket #5041 **$44.50** (2.98)
Extra dovetail mounting plate #5050 **$12.95** (2.19)

Low-Profile Helical Focusers

Economical yet precise focusing. Ideal for fast optical systems. Cast aluminum base with threaded machined aluminum inner tube.
1.25" #13014 **$39.95** (2.45)
2.0" #13016 **$64.50** (2.98)

Rack-and-Pinion Focusers

Finest in their class! Diagonal-cut plated brass racks, oversized knurled knobs, long focus travel.
1.25" #13007 **$59.95** (2.98)
2.0" includes 1.25" adapter.
#13003 **$99.95** (3.95)

MONEY-BACK GUARANTEE
If you are not completely satisfied with your purchase from Orion, for any reason,
100% Satisfaction
just return it in new condition within 30 days after delivery for a prompt refund

IT'S EASY TO ORDER!

- Call toll-free and charge to your MasterCard, Visa or Discover Card or send your personal check to order by mail.
- California residents add 7.25% sales tax (8.25% in Santa Clara and Santa Cruz Counties, 8.5% in San Francisco).
- Shipping & handling charge for UPS Ground or US Mail to lower 48 United States are listed in parentheses after each price. We ship to U.S. and Canada only.
- We expected the prices in this ad to be accurate for December 1994 at the time of our advertising deadline in October. Please call our toll-free number for current pricing and to receive our latest catalog. Prices are subject to change or correction without notice.

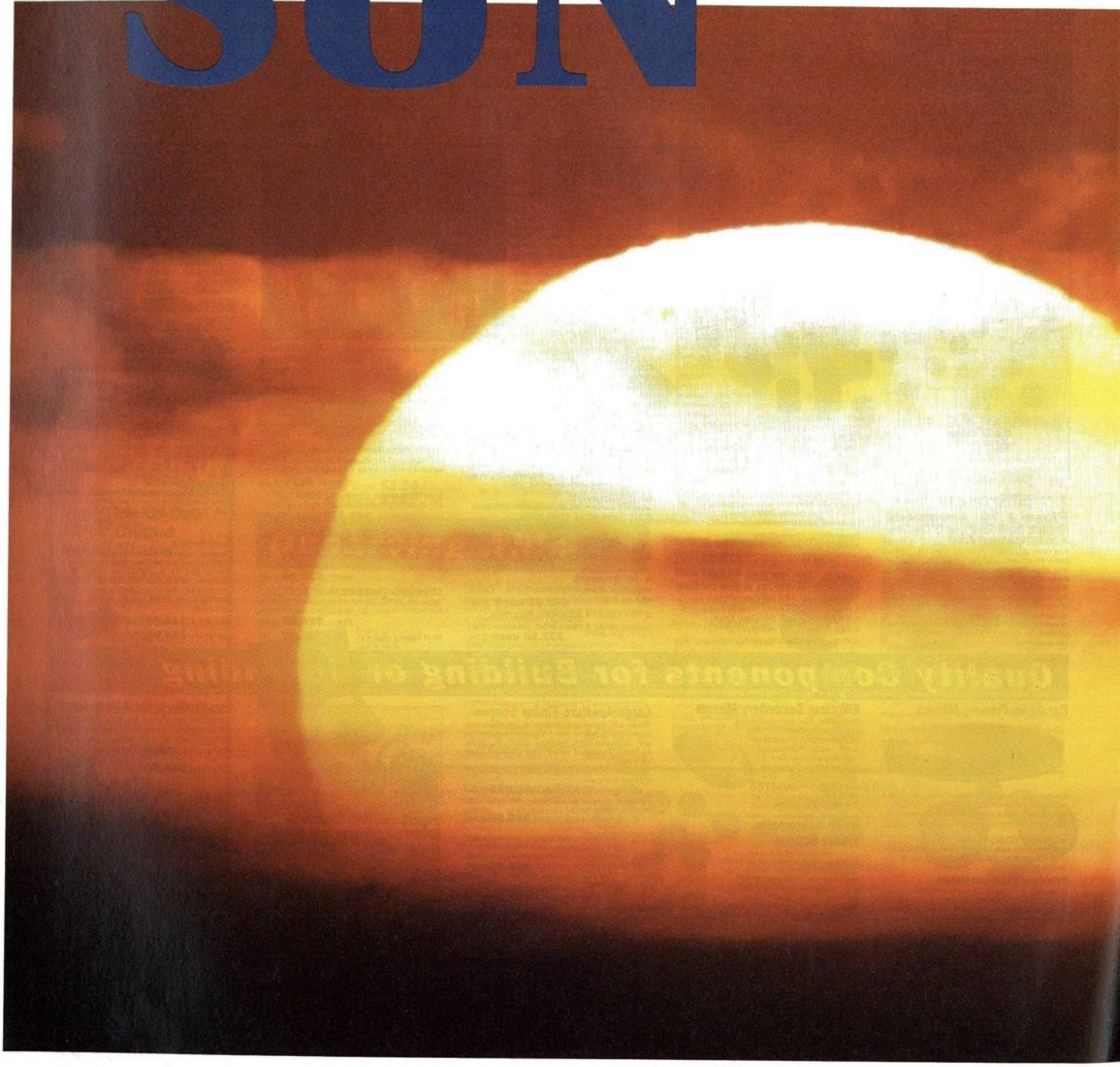
ORION
TELESCOPE CENTER
2450 17th Ave., P.O. Box 1158-A
Santa Cruz, CA 95061-1158
When ordering, mention key code LMA
Business Offices (408) 464-0446

Call Toll-Free 800-447-1001

Journey to the Heart of the SUN

Energy generated in the Sun's core takes a million years to reach its surface. The trip leaves subtle traces that unveil the internal structure of our star.

by David H. Hathaway



James Boyd

Every second a huge amount of energy pours out of the Sun, providing the inhabitants of Earth with light and heat. Created deep in the Sun's hydrogen-burning heart, this energy flows from the Sun's visible surface. The brightness of the surface, however, prevents astronomers from gazing directly into the Sun's interior, even though it's less than one-thousandth of the Sun's radius thick.

Without a direct view inside, researchers have struggled to learn how the Sun generates energy and how that energy moves from the center to the surface. Fortunately, the energy leaves behind traces of its motion as it passes through the Sun, and solar astronomers are learning how to read these telltale signs and what they reveal about the star's interior.

Unraveling the motion of the energy first requires understanding how the escaping energy interacts with gas at the surface. And then deciphering what the motion says about the interior requires tracing the path of a packet of energy, or photon, back to the Sun's center.

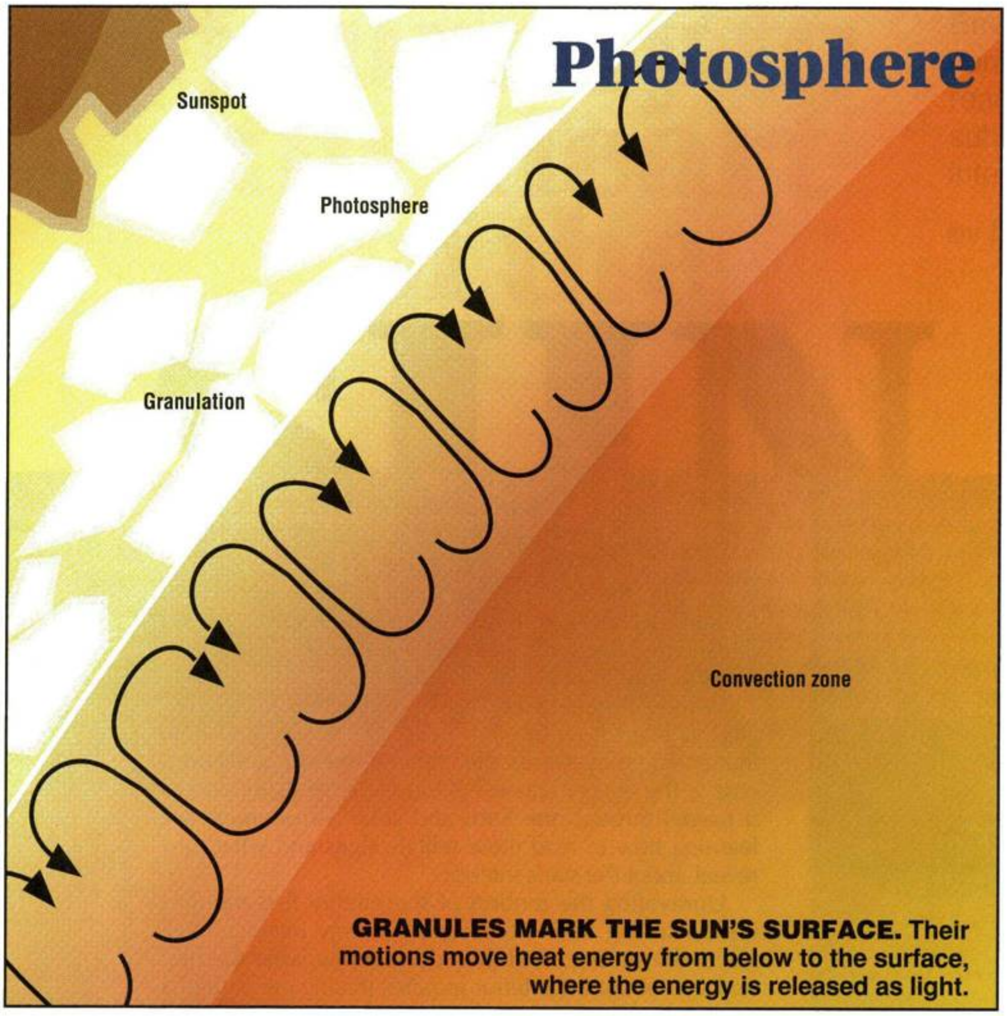
Photons of light escape from the surface, a layer several hundred kilometers thick aptly named the photosphere. A close look at the photosphere reveals that it has a rice-grain pattern, called granulation, which results from gas motions in the Sun's atmosphere (see the illustration on the next page). Granules have diameters of about 1,000 kilometers, so more than a million of them cover the Sun's surface. They reach a depth of about 300 km, about the same depth as the photosphere.

Granules result from convection, the transfer of heat energy by the motion of material. Just below the photosphere the hydrogen gas has a temperature of about 20,000 kelvins, which is cool enough to allow hydrogen nuclei to capture electrons. The capture provides a kick to the gas motions, creating granules.

The centers of granules are bright because material there upwells (at around 2 km/s) from hotter layers below. Surrounding the irregularly shaped granule is a dark lane of sinking material that is still quite hot, but it appears darker because it is a few hundred kelvins cooler than the 6000 K gas in the granule.

Observations of granules reveal that they live for 20 minutes on average. An observer tracking the gas motions of granules also notices another phenomenon

THE BRIGHT FACE OF THE SUN **results from the escape of energy that started its journey deep in the Sun's interior.**



GRANULES MARK THE SUN'S SURFACE. Their motions move heat energy from below to the surface, where the energy is released as light.

ASTRONOMY: illustrations by Lee Vande Visse and Tom Hunt

called the five-minute oscillations. Gas motions near the surface create low-frequency sound waves, also called pressure modes or p-modes, that cause patches of the surface to rise and fall about every five minutes.

One key for probing the Sun's interior is to study how the sound waves bounce around the surface. Because temperature increases inward, the speed of sound also increases inward. The increasing speed of sound below the photosphere bends the inward-moving waves back toward the surface. The outward-moving sound waves can't penetrate the surface, so they bounce off the surface and travel inward once again. The distance between bounces reflects the depth to which the wave penetrated.

Besides the granules and sound waves, astronomers detect other motions at the Sun's surface. Granules have a larger counterpart called supergranules (see illustration opposite). Supergranules aren't visible to the eye because the small temperature difference from center to edge gives rise to an insignificant change in brightness. They appear only in observations of the gas motions. Gas gently spreads out (at about 0.5 km/s) from the centers of these convection cells and sinks at their edges. Supergranules are about 30 times larger than granules, with diameters of around 30,000 km, depths of 10,000 km, and a lifetime of about two days.

They, like the granules, help to bring up heat from lower layers to the Sun's surface. And like the granules, their motions get kick-started. About 20,000 km below the surface, the temperature reaches 150,000 K. Below this region, helium nuclei have no electrons orbiting them. But in this region, helium nuclei capture their first electrons, giving the extra push needed to form supergranules.

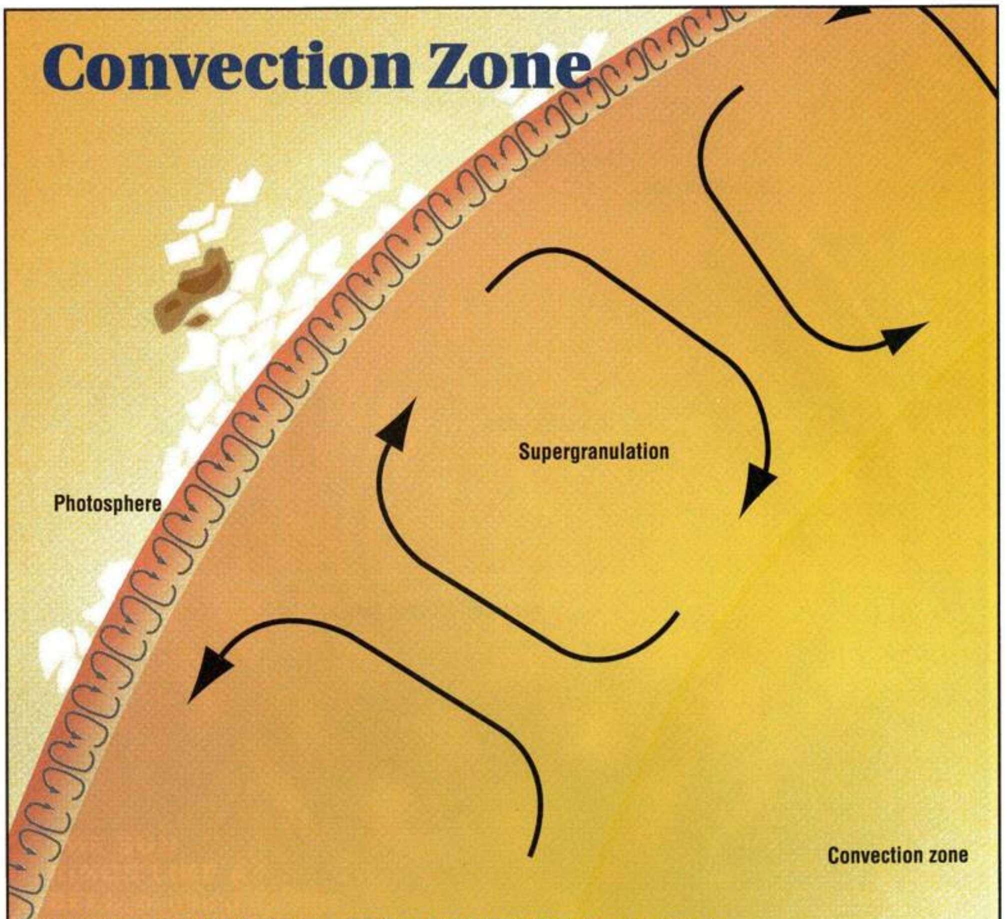
Besides the motions of the granules, supergranules, and sound waves, another motion of the surface captures astronomers' attention — rotation. The Sun rotates once in about 27 days, but because the Sun is a ball of gas it does not have to rotate at the same rate everywhere. Indeed, observations show that gas near the Sun's equator rotates in 24 days while gas near the poles takes more than 30 days to rotate. This "differential rotation" of the Sun results from the interaction between the Sun's rotation and gas motions in the layer beneath the photosphere.

This layer, called the convection zone, extends about 150,000 km below the photosphere, roughly a quarter of the way to the Sun's center. (See illustration on page 40.) Solar astronomers think broad, slow-moving gas currents called giant cells carry the heat upward from the bottom of the layer, which has a temperature of 2 million K. As the rising gas approaches the surface, it expands and cools. Colder gas sinks to the bottom to be heated by energy from below so it can again rise and carry energy toward the surface.

The Sun's rotation plays an important role in the dynamics of the convection zone. While it is too slow to influence the rapid convective motions in granules and supergranules, its effect on giant cells is dramatic. Rotation stretches giant cells north-to-south while keeping them narrow east-to-west. The resulting giant cells resemble bananas with their small ends near the poles.

The horizontal flow in these cells is mostly east and west. However, the Sun's west-to-east rotation makes the eastward flows turn toward the equator. This motion adds to the rotation and speeds up the equatorial regions so they rotate more rapidly than the average. Westward flows turn toward the poles and act against the rotation, causing the polar regions to rotate more slowly.

Gas motions in the convection zone also control the



SUPERGRANULES DREDGE UP HEAT from deeper in the Sun's convection zone than the granules do, but still reach down only one percent of the way to the Sun's center.

Sun's magnetic fields. The best known products of these fields are the dark sunspots. During an 11-year cycle, sunspots increase in number and slowly migrate from high to low latitude.

In many ways, magnetic fields behave like rubber bands. They can stretch, twist, and break, and they can fold back on themselves to become stronger. Differential rotation stretches out the Sun's magnetic field and wraps it around the star like thread wound on a spool. This strengthens the field so much that it pushes outward against the surrounding gas, eventually breaking through the surface like segments of a giant sea-serpent. The magnetic field at the surface stops the flow of heat, creating the cooler sunspots.

Below the convection zone lies the radiative zone, extending from 25 to 90 percent of the way to the center. As its name implies, energy moves through the radiative zone by radiation, namely as photons of energy. Temperature increases slowly through the radiative zone from 2 million K near the convection zone to around 10 million K at its bottom. Throughout this layer, the gas is hot enough to keep the nuclei of hydrogen, helium, and most of the heavier elements completely stripped of electrons.

The border between the convection and radiative zones occurs where the temperature allows some heavy nuclei to capture electrons. This makes it more difficult for photons to pass through the gas because atoms absorb and scatter light more efficiently than bare nuclei and electrons do. The increased light-absorbing ability, or opacity, traps some of the radiation, which keeps the temperature elevated. Atoms also have a greater capacity to hold heat than bare nuclei do. These two effects, increased opacity and heat capacity, make gas motions a more efficient way of transporting energy than radiation. So from this point outward, convection carries the heat, while inside radiation dominates.

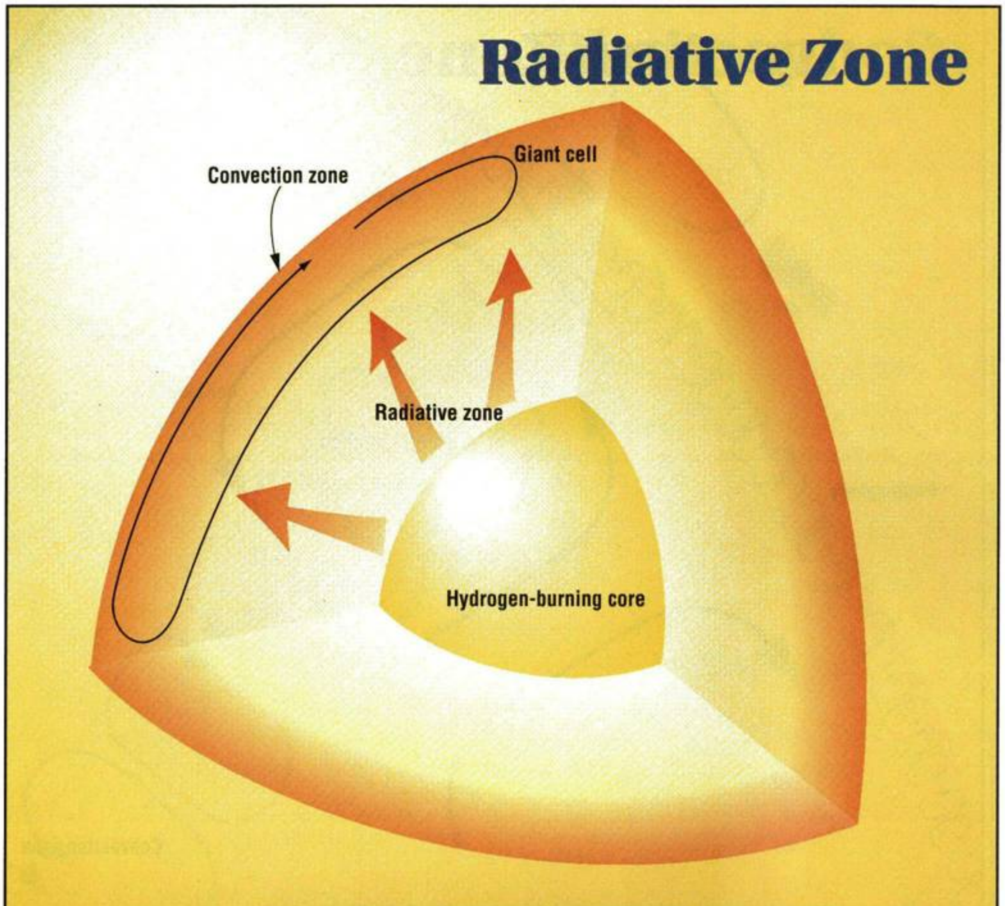
All of the energy arises from nuclear burning deep within the Sun's core. At the center, the temperature reaches 15 million kelvins and the pressure compresses gas to a density about 10 times that of gold or lead. These conditions cause hydrogen nuclei to fuse together, creating helium and giving off energy in the form of X rays. These nuclear reactions take place in the innermost 10 percent of the Sun, a volume about the size of the planet Jupiter.

Reaching the core, we can now summarize the path of energy from its source to the surface where it escapes into space. X rays generated by hydrogen fusion rattle around in the core, traveling only a small fraction of a millimeter before being absorbed and reradiated by an atom. Light travels from the Sun's surface to Earth, a journey of 150 million km, in a little over 8 minutes. In the same time, an X ray travels only 1 centimeter in the Sun's interior.

The X rays slowly work their way from the core and next wind their way through the radiative zone. The energy has to heat more and more gas as it moves out, so temperatures in the radiative zone drop. By the time the photons reach the junction of the radiative and convection zones, the gas reradiates the energy at longer wavelengths but still as X rays.

When the photon enters into the convection zone, it heats the surrounding gas. But instead of reradiating the energy, the gas now rises, carrying the heat energy with it. The motion is part of a larger ballet by giant cells that try to carry the heat all the way to the surface.

About 20,000 km from the surface, the dropping temperature causes atoms to form and smaller supergranules to transport the bulk of the heat. Closer to the surface, granules (rather than supergranules) are more efficient and carry the heat to the surface. The



GIANT CELLS MOVE HEAT from the base of the convection zone to the surface. Photons of light carry the energy from the nuclear-burning core to the convection zone.

cool, low-density gas of the photosphere becomes transparent and radiates as visible light the energy of the X rays generated a million years ago in the core.

This basic picture of the Sun has existed for decades and forms a cornerstone for understanding other stars. No one doubts that this model is basically correct, but it hits snags when researchers try to meld it with theories describing the Sun's magnetic field.

Solar astronomers have developed two classes of theories to explain the behavior of the Sun's magnetic activity cycle. The first class makes assumptions about how giant cells twist and fold the magnetic fields and then explores how differential rotation must change with solar radius to reproduce the observed behavior of the activity cycle. These theories predict that the Sun's rotation rate must increase inward through the convection zone. Otherwise the average latitude of sunspots would not migrate toward the equator during the 11-year sunspot cycle as observed.

The second class models the structure and dynamics of the solar interior and allows convective motions to produce the differential rotation. In these theories, the Sun's rotation rate decreases inward through the convection zone. Although these models represent convection and differential rotation in an internally consistent way, they fail to reproduce the observed magnetic behavior — the average latitude of sunspots through the activity cycle moves poleward instead of equatorward. And both groups of theories tend to produce short sunspot cycles, one to two years in length instead of the required 11 years.

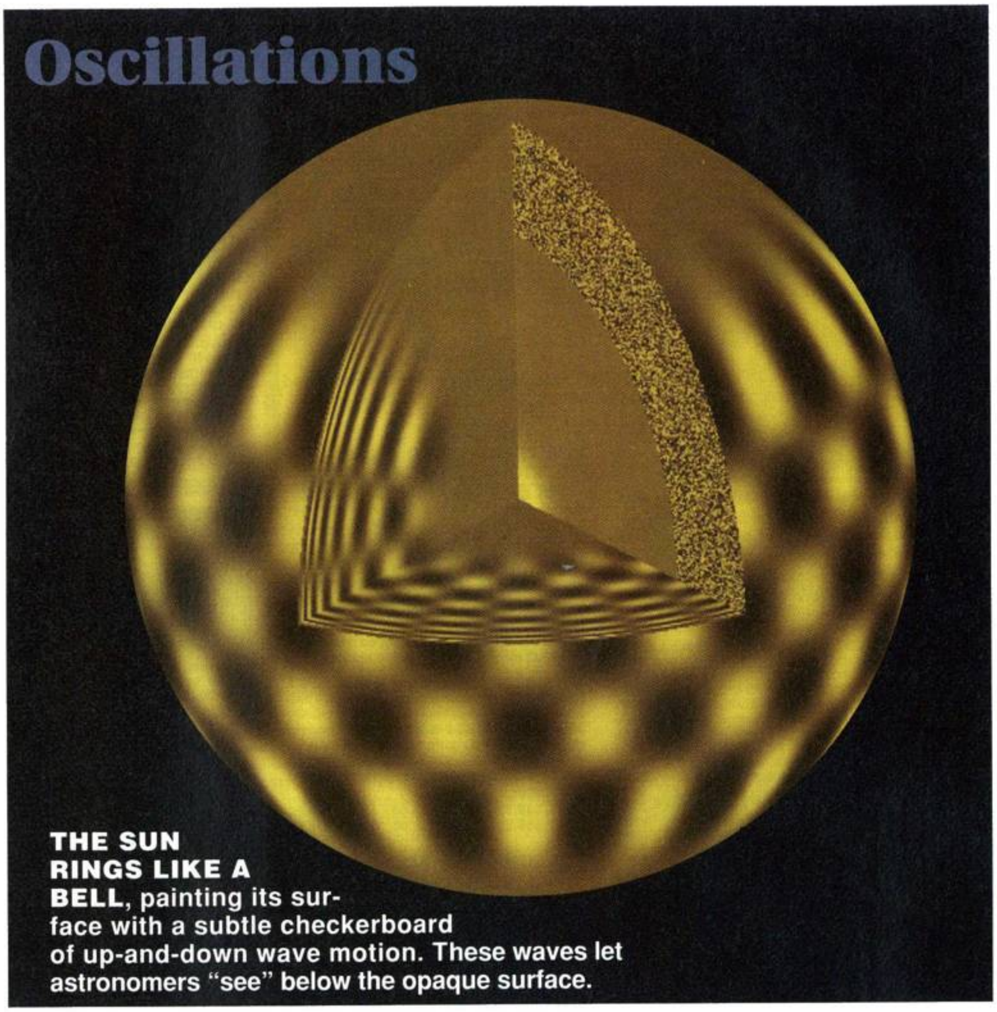
The fundamental problem is that convective motions seem to be too efficient in moving magnetic fields around in the convection zone. Better theories are needed, but actual observations of the giant cell convection and the internal differential rotation rate would be far more useful in furthering understanding of the solar interior. Direct views of these features are impossible because the opaque photosphere hides them, but solar astronomers have borrowed a trick from geologists to peer below the surface.

On Earth, seismologists use seismic waves (essentially sound waves traveling through rock) produced by earthquakes to probe our planet's interior. By measuring the properties of sound waves in the photosphere, helioseismologists can determine both the structure and motions of the Sun's interior.

Sound waves produced by convection become trapped within the Sun and set up a pattern of vibrations. By measuring the speeds of different waves, astronomers can determine the temperature of different layers because the speed of sound increases as temperature increases. Likewise, they can deduce internal motions by measuring the difference in the speed of waves moving in opposite horizontal directions.

To "see" below the surface, observers must accurately determine both the structure of the waves (the pattern on the surface) and their periods — the intervals between wave peaks. This requires imaging the Sun almost continuously — once a minute for many weeks — and with high spatial resolution.

Early efforts to observe the waves have produced some results. These measurements indicate that the base of the convection zone lies at a depth of 200,000 km, compared with the 150,000 km that theories suggested. Other wave measurements show that helium makes up about 24 percent of the mass of the convection zone, about what theorists predicted.



THE SUN RINGS LIKE A BELL, painting its surface with a subtle checkerboard of up-and-down wave motion. These waves let astronomers "see" below the opaque surface.

NOAO

And it appears that the differential rotation rate seen at the surface remains constant through the convection zone. This contradicts both classes of theories for the solar activity cycle. The rotation rate, however, does change at the base of the convection zone. In the transition layer between the radiative and convection zones, the differential rotation slowly disappears. Gas in the radiative zone rotates at nearly the same rate, as a rigid body such as Earth rotates.

These observations lead researchers to believe that the source of the Sun's magnetic cycle is in the gas motions of the transition layer. The nature of the magnetic fields also supports this. If a magnetic field arose in the convection zone, it would rise so rapidly through the zone that convective motions would have too little time to act on it. On the other hand, magnetic fields anchored in the transition layer would be stretched out by the differential rotation and twisted and folded by convective flows that penetrate into the region from above. With this insight, theorists have redoubled their efforts to find a model that reproduces the activity cycle.

Advances in this new model may be spurred on by two new efforts to observe solar waves and oscillations. Most solar observatories can observe for only 10 to 12 hours a day and for a few days at a time while the weather cooperates. From the South Pole, astronomers have observed the Sun for several days without interruption but only for a few weeks out of the year.

To get around this, the National Solar Observatory in Tucson, Arizona, is building six identical instruments to measure the oscillations. These instruments will form the Global Oscillation Network Group to observe from six different sites around the world. GONG already has a prototype on line in Tucson and will start deploying equipment to the other sites during early 1995. This network of observatories will obtain nearly continuous observations of solar oscillations for three years.

NASA and the European Space Agency are funding a similar instrument to be flown on the Solar and Heliospheric Observatory (SOHO) mission in the summer of 1995. This space-based instrument will have two months of continuous observations with much higher spatial resolution than GONG and without the distortion due to Earth's atmosphere that GONG will experience. It will then continue to observe for the rest of a year with somewhat less spatial resolution and then repeat the process for two more years.

Together, the observations from GONG and SOHO should reveal new information about the dynamics and structure of the Sun's interior. In particular, the new observations should better resolve the structure and motions in the region between the radiative and convection zones. After 20 years of trying, solar astronomers may finally glimpse giant cells in the convection zone and discover whether they conform to expectations. They may learn new things about the radiative zone and the core, both of which have remained masked from sight until now. The core might be rotating rapidly as some scientists have predicted, and we could find circulating currents in the presumably featureless radiative zone. Undoubtedly the view of the Sun's interior in 1998 will be dramatically different than the present one, thanks to GONG and SOHO. □

David H. Hathaway is a solar astronomer at NASA's Marshall Space Flight Center who specializes in the study of the Sun's surface and internal motions.

Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery, competitive prices

LUMICON FOR HIGH PERFORMANCE

LUMICON H-BETA
LUMICON OIII
OIII
LUMICON UHC
LUMICON DEEP-SKY

FILTER OF THE MONTH: LUMICON **H-Beta Filter** will help you see the Horsehead Nebula from a dark site and 10" or larger telescope.

"I'd Pick The TELE VUE™"

40mm Wide-Field Test, "Astronomy," Aug. 1990, p. 90

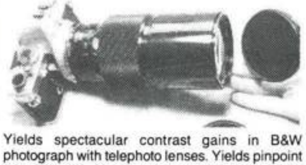
Genesis 4" f/5 4 element fluorite	**$1885**
Pronto 70mm f/6.4 apochromat w/2" diagonal	**$825**
Pronto 70mm f/6.4 w/45° erecting prism	**$725**
Renaissance-SDF 4" f/5.4, brass	**$2095**
Gibralter mount with ash wood tripod	**$495**
7.4, 10.4, 13, 17, 21, 26mm Plossl 50°	**$79**
1.8x or 2.5x Tele Vue Barlow Lens	**$89**
2" Giant Barlow - 2x	**$169**
32mm Plossl, widest true field in 1¼"	**$109**
55mm 2" Plossl, widest possible field	**$219**
15mm Wide-Field, 1¼" eyepiece, 65°	**$135**
19mm Wide-Field, 1¼" eyepiece, 65°	**$145**
32mm Wide-Field, 2" eyepiece, 65°	**$239**
40mm Wide-Field, "Rich-Field!" 65°	**$299**
4.8mm Nagler, 82° field, 1¼" eyepiece	**$149**
7mm Nagler, 1¼" eyepiece, 82° field	**$189**
9mm Nagler, 82° field, 1¼" or 2"	**$219**
13mm Nagler, 82° field, 1¼" or 2"	**$249**
12mm Nagler, Type II, 82°, 1¼"/2"	**$249**
16mm Nagler, Type II, 82°, 1¼"/2"	**$289**
20mm Nagler, Type II, 82°, 2" only	**$340**
1¼" Paracorr Visual Coma Corrector	**$159**
2" Paracorr Visual Coma Corrector	**$249**
NEW! 15mm Panoptic 1¼", 68° field	**$199**
NEW! 22mm Panoptic 1¼"/2", 68°	**$249**
NEW! 27mm Panoptic 2", 68° field	**$299**
NEW! 35mm Panoptic 2", 68° field	**$325**

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

LUMICON Adjust. Piggyback Mount $59.50
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER



Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	**H-Alpha**	**(MV)**
46, 48, 49mm	**$59.00**	**$49.00**
52, 55, 58, 62mm	**$69.00**	**$59.00**
67, 72, 77mm	**$79.00**	**$69.00**
82mm	**$89.00**	**N/A**

Hypered 2415 film, 36 exp .. **$11.95, $3/$32**

LUMICON®

2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (510) 447-9570
FAX (6 PM-9 AM PST) (510) 447-9589
LUMICON Products catalogue FREE
All foreign orders add 8% ($10 minimum)
California residents add 8.25% tax.
Prices subject to change w/o notice.
Hrs: M-F 9 am - 5 pm, Sat. 11 am - 3 pm

NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding up to an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32"	**$39.50**	1.52"	**$45.00**	1.83"	**$49.50**
2.14"	**$59.50**	2.60"	**$75.00**	3.10"	**$99.50**

ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror)	**$99.50**
2" (1.83" mirror)(see photo above)	**$165.00**

LUMICON FILTERS — BEST IN THE WORLD!

"The LUMICON OIII proved to be our favorite... It gave the greatest contrast gain."
ASTRONOMY February 1991

AMAZING OIII FILTER™

Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90-96% for both O-III lines at 496nm and 501nm.

"I CAN SEE THE VEIL NEBULA!"

Rich Zepernick saw the Veil Nebula for the very first time with a **LUMICON UHC Filter**. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without thésc filters."*
Rich Zepernick, Cresskill, NJ

SEE THE HORSEHEAD!

Horsehead Nebula in Orion. This faint nebula is seen best with a LUMICON H-Beta Filter. Photo by J. Marling using a Deep-Sky Filter.

DEEP-SKY FILTER™

BEST for Astrophotography!

"Stunning is all I can say," says noted astrophotographer Jack Newton. Great for BOTH color and black and white photography.

BEST WIDE-BAND FILTER!

"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for ***reflection*** *nebulae."*
Astronomy, Feb. 1991

	Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces	**$59.50**
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces	**$79.50**
48mm LUMICON DEEP-SKY Filter (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	**$119.50**
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	**$119.50**
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)	**$299.50**
2" Rear Cell Filter, fits SCT's ... Deep-Sky, **$119.50** UHC, O-III, H-Beta,	**$199.50**
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces	**$99.50**
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	**$199.50**
Set of both premium **DEEP-SKY** and **UHC Filters** (Save 11%) ... 1¼" **$159.50**; 48mm	**$279.50**
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"** ... **$99.50, 48mm**	**$199.50**
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines ... **1¼" $99.50, 48mm**	**$199.50**
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm	**$6.95**
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece	**$16.00**
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece	**$20.00**

**Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

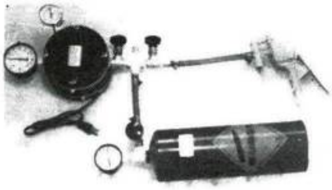
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**



MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$325**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	**$189.50**
3X Relay Diagonal (see photo)	**$89.50**
Illuminated reticle eyepiece, pulsed	**$109.50**
Guider for Hasselblad **$409**, Mamiya 645	**$199**
Pentax 6X7 **add $119**; Pentax 645	**add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER	**$249.00**
Adapter for Hasselblad **$225,** Mamiya 645	**$98**
Pentax 6X7 **add $119;** Pentax 645	**add $139**

GIANT EASY-GUIDER™

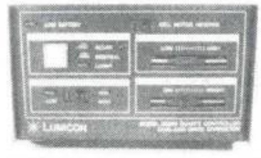
For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER	**$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20)	**add $99.95**
Adapter for Hasselblad **$295**, Mamiya 645	**$149**
Pentax 6X7 **add $129**; Pentax 645	**add $149**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

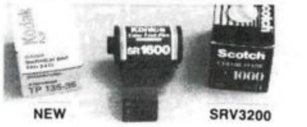
2. Cable release for long exposures .. **$9.95**



3. **LUMICON Digital Drive Corrector** . **$249**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 30Hz/90Hz variable output controls telescope drive. 60Hz digital reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Dec. reverse switch for Newtonians.

Declination motor (state telescope) ... **$109**
Variable dec. speed drive w/built-in 5AH battery **$299**

HYPERSENSITIZED FILM



YES! WE STILL HAVE FUJI HG400!

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.). ***No C.O.D.s.***

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	**$11.95**
SR-G3200, fastest of all, color neg	24	**$13.95**
Kodak Ektar 1000 fast, fine grain	24	**$12.95**
Fuji HG400 fine grain color neg.	24	**$14.95**
Scotchrome 400, fast slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

NEW MEADE® 16'' LX200 $14,950 AT LUMICON

"What an astounding combination of high performance and low price!" Jack Marling, Ph.D., owner of LUMICON

TOLL-FREE ORDER LINE 1-800-767-9576 EXPERT INFORMATION 1-510-447-9570 FAX 1-510-447-9589

MEADE APOCHROMAT ED REFRACTORS

7'' f/9 Apochromat
Only
$5495

Meade 6'' f/9 Model 152ED Refractor shown with #1697 Computer.

See the Meade ad in this magazine for full specifications and product descriptions. ED = Extremely low dispersion glass which yields color-free virtually perfect images. PPEC = Permanent Periodic Error Correction "Smart Drive."

Model 102 ED 4'' f/9 Apochromat & mount (add $105 P&S) **$2495**
Model 127 ED 5'' f/9 Apochromat & mount (add $125 P&S) **$2995**
Model 152 ED 6'' f/9 Apochromat & mount (add $185 P&S) **$4495**
Model 178 ED 7'' f/9 Apochromat & mount (add $215 P&S) **$5495**
Medium format adapters ...... Mamiya 645, **$98;** Pentax 6X7, **$98**
Med. format EASY-GUIDER™: Mamiya 645, **$298;** Pentax 6X7, **$298**
Medium format EASY-GUIDER for Hasselblad **$495**

DRIVE SYSTEMS

#1697 Computer Drive, 747 object computer memory, automatic slewing to desired object **$695**
8,000 Object CNGC Library .. **$99** Polar alignment finder .. **$99**

OPTICAL TUBE ASSEMBLIES (OTA)

Model 102 ED/OTA 4'' f/9 OTA only (add $55 P&S) **$1045**
Model 127 ED/APO-OTA 5'' f/9 OTA only (add $60 P&S) **$1595**
Model 152 ED/APO-OTA 6'' f/9 OTA only (add $100 P&S) .. **$2295**
Model 178 ED/APO-OTA 7'' f/9 OTA only (add $120 P&S) .. **$3250**
Cradle ring assem. 4'' (4½'' OD tube) **$135;** 5'' (5½'' OD tube) **$145**
Cradle ring assem. 6'' (7'' OD tube) **$169;** 7'' (8'' OD tube) **$219**

EQUATORIAL MOUNTS

LXD 650 mount and standard field tripod (add $50 P&S) .. **$1595**
LXD 750 mount and giant field tripod (add $100 P&S) **$2475**

NOTE: Add the indicated packing and shipping (P&S) costs to each telescope for insured UPS shipment to your door.

MEADE DOBSONIANS

Drop shipped from Meade, add shipping charge in parenthesis.

6'' f/8 Starfinder Dobsonian ($46) **$295**
8'' f/6 Starfinder Dobsonian ($59) **$395**
10'' f/4.5 Starfinder Dobsonian ($85) ... **$565**
12.5'' f/4.8 Starfinder Dobsonian ($95) .. **$765**
16'' f/4.5 Starfinder Dobsonian ($55) .. **$1295***

**Shipped truck freight collect; add $55 packing charge. Includes #682 focuser.*

NEW MEADE EYEPIECES

Series 3000 Plossl 1¼'' eyepieces: select 5mm, 6.7mm, 9.5mm, 16mm, 25mm ($3.45) .. **$57.95**
Select Any 3 . **$48.95 ea.;** Any 5 . **$46.95 ea.**
Series 3000 40mm Plossl 1¼'' eyepiece **$79.95**
Shipping charges of 4-5% are extra.

NEW MEADE 16'' LX200 SCHMIDT-CASSEGRAIN

8'' LX200
$2495

16'' LX200 $14,950

NEW Meade 8'' LX200 Telescopes

See the Meade ad in this magazine for full specifications & details. **LX100 Drive,** 2X, 32X speed control with PPEC (Permanent Periodic Error Correction "Smart Drive") & dual-axis hand controller. **LX200 Drive,** Full electronic control with PPEC, 747 object computer memory and automatic computer controlled slewing to desired object. *NOTE:* A wedge is **not** needed for visual observing with the LX200 Drive. Select f/10 or f/6.3 (no extra charge) for your Schmidt-Cassegrain.

8'' LX100 Schmidt-Cassegrain with wedge (add $105 P&S) **$2099**
8'' LX200 Schmidt-Cassegrain with computer (add $105 P&S) **$2495**
Wedge for photographing with 8'' LX200 .... **$139**
10'' LX100 Schmidt-Cassegrain w/super wedge (add $145 P&S) **$2895**
10'' LX200 Schmidt-Cassegrain with computer (add $145 P&S) **$2895**
NEW! 12'' LX200 (f/10 only) with computer (add $215 P&S) **$3995**
Super Wedge for photography with 10'' or 12'' LX200 ..... **$395**
NEW! 16'' LX200 f/10 w/super giant tripot (add $385 P&S) **$14,950**
Dew Shields: 8'' - **$119;** 10'' - **$129;** 12'' - **$189;** 16'' - **$289**
Library Options (ver. 3.2 only) 10,600 objects **$99;** 64,350 objects **$149**

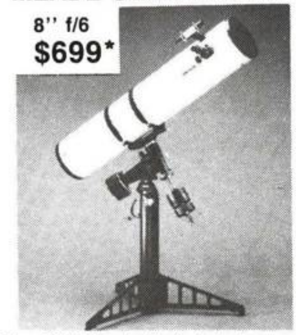
OTHER SCHMIDT-CASSEGRAINS

Meade 2045D 4'' f/10 with motor drive (add $40 P&S) **$699**
Meade 2080B 8'' f/10 with tripod, wedge, MCOG (add $85 P&S) **$1249**
Model 2120B 10'' f/10 w/wedge, tripod, MCOG (add $125 P&S) **$1599**

PHOTOGRAPHY ACCESSORIES

LUMICON Cassegrain EASY-GUIDER 4'', 8'' only, f/6 or f/10 . **$249**
LUMICON Giant EASY-GUIDER for 10'' or 12'' f/4-f/10 operation **$395**

MEADE STARFINDERS



New 8'' f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions. These are complete telescope systems with motor drive, mount, finderscope and 25mm (=48X) eyepiece.

6'' **f/8 Starfinder 6**(add $79 P&S) **$599**
8'' **f/6 Starfinder 8** (add $89 P&S) **$699**
10'' **f/4.5 Starfinder 10** (add $99 P&S) **$799**
16'' **f/4.5 Starfinder 16** (ship. freight COD) . **$2495**

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated shipping charge to the price. Slightly lower P&S for payment by check. LUMICON showroom prices are $99 higher.

ACCESSORIES

LUMICON carries the full line of Meade accessories. See the Meade ad in this magazine for detailed prices and descriptions.

LUMICON Single axis drive corrector . **$99**
LUMICON DX200 Dual-axis drive cor. **$249**
Meade 47M Dual-axis drive corrector with tangent arm & electric declination .. **$475**
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack **$299**

LUMICON® SKY VECTOR™

Higher Performance — Lower Price

LUMICON ACCESSORIES

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550 (510) 447-9570 FAX (510) 447-9589

LOW PRICE—from $399

LUMICON SKY VECTOR FEATURES:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital decl. readout to 10 arc-min.
- 4000 pulse (0.09° accuracy) encoders
- Polar alignment ***not required!***
- Motor drive ***not required!***
- Just sight two stars to align!
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- **No need** to enter latitude, longitude, etc.

SKY VECTOR I™ $399

NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ $499

IMPROVED — Planets, Over 3,700 Objects! With size, magnitude and full visual description.

NGC SKY VECTOR™ $699

IMPROVED!—5500 Additions / Corrections

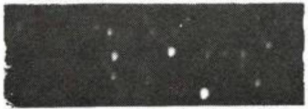
NGC-Sky Vector™
OFF ON
DIM
MODE
ENTER
UP
DOWN
LUMICON®

Improved NGC SKY VECTOR with over 12,000 object memory including the planets, complete, corrected RNGC catalogue, IC catalogue, P&K planetary catalogue, & much more!

Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR



Coma 1 inch off-axis 17½'' f/4.5

Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2'' lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2'' EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8''.

LUMICON 48mm Coma Corrector/Field Flattener Lens **$285.00**
LUMICON 2'' EASY-GUIDER . **$169.50**
2'' EASY-GUIDER (Mamiya 645) **$199.50**
2'' Adapter for Pentax 6X7 ... **$129.00**
2'' Adapter for Hasselblad . **$229.00**
2'' Adapter for Bronica SQ-A **$175.00**
2'' Extension for viewing ... **$26.00**

2'' DELUXE BARLOW

1.8x Multiplier Lens (2'' Barlow)

LUMICON 1.8x Multiplier Lens (2'' Barlow) **$235.00**

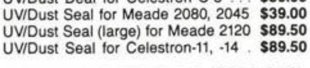
LARGE UV/DUST SEAL

Protect the optics of your 8-14'' Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

Deep-Sky Filter/Dust Seal for C-8, 2080 ... **$119.50**
UV/Dust Deal for Celestron C-8 .... **$39.00**
UV/Dust Seal for Meade 2080, 2045 **$39.00**
UV/Dust Seal (large) for Meade 2120 **$89.50**
UV/Dust Seal for Celestron-11, -14 . **$89.50**

LOW PROFILE FOCUSERS
New! Thread-on for Odyssey

FROM $69.50



LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½'' above the telescope tube. Use the 1¼'' or 2'' versions for viewing. Use the 2'' non-rotating focuser for convenient photography with the LUMICON 2'' EASY-GUIDER™.

Select your desired base-plate shape! Coulter Odyssey (thread-on installation), Flat, 7'' OD, 9½'' OD, 12½'' OD, 16'' OD, 21'' OD.

LUMICON 1¼'' Helical Focuser **$69.50**
LUMICON 2'' Helical Focuser 1½'' high **$75.00**
LUMICON Non-rotating Helical Focuser **$129.00**
2'' Astro Systems focuser, only 2'' high **$139.00**
3 handles for non-rotating focuser **$12.95**
2''/1¼'' adapter w/48mm filter threads **$20.00**
2'' LUMICON EASY-GUIDER **$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼'' 50mm Finderscope **$59.50**, right-angle **$59.50**
1¼'' straight-thru 80mm SUPER-FINDER . **$179.50**
1¼'' right-angle 80mm SUPER-FINDER .. **$189.50**
1¼'' right-angle version, w/star diagonal .. **$229.50**
25mm Cross-hair 1¼'' eyepiece (12X) **$49**
Large mounting rings for 80mm Finder **$55**
1¼'' Star Diagonal **$49**, Mounting Brackets, **$39.50**
1¼'' 45° diagonal for correct left-right views **$52.44**

LOTS OF ADAPTERS

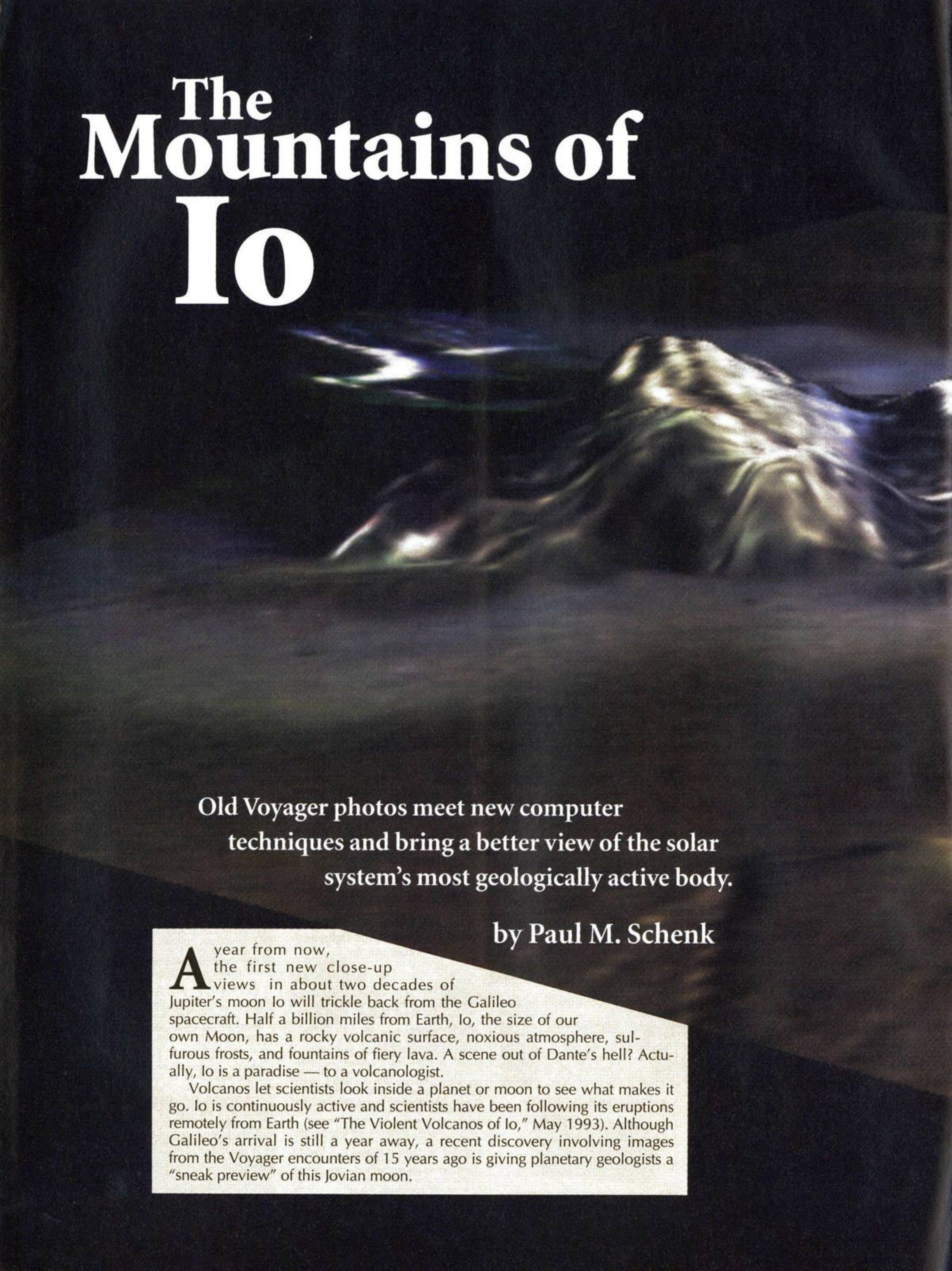
2'' adapter for C-8, Meade 2080, etc. .. **$26.00**
2'' adapter for C-80, C-100 refractor ... **$39.50**
2'' adapter for C-70, C-80F, C-100F fluorite **$39.50**
2'' adapter for C-6, Comet Catcher, Meade 312 **$30.00**

EXTENSION TUBES

1'' long 1¼'' OD thread-in extension **12.00**
2½'' long extension (holds 1¼'' filters) . **19.50**
4½'' long extension for 1¼'' eyepieces **$25.00**
3'' long extension for 2'' eyepieces* .. **$26.00**
2'' long extension for 2'' eyepieces* .. **$26.00**

VIEWING ADAPTERS

2''/1¼'' reducing bushing,threaded 48mm* **$25.00**
2''/T-thread adapter, threaded 48mm* .. **$25.00**
T-thread/1¼'' adapter **$25.00**
F/10 2'' or 1¼'' eyepiece viewing adapter for Giant Easy-Guider **$39.50**
Low profile star diagonal eyepiece holder **$16.00**
Meade 2'' Diagonal/Giant Easy-Guider **$39.50**
**Threaded to hold 48mm filters.*



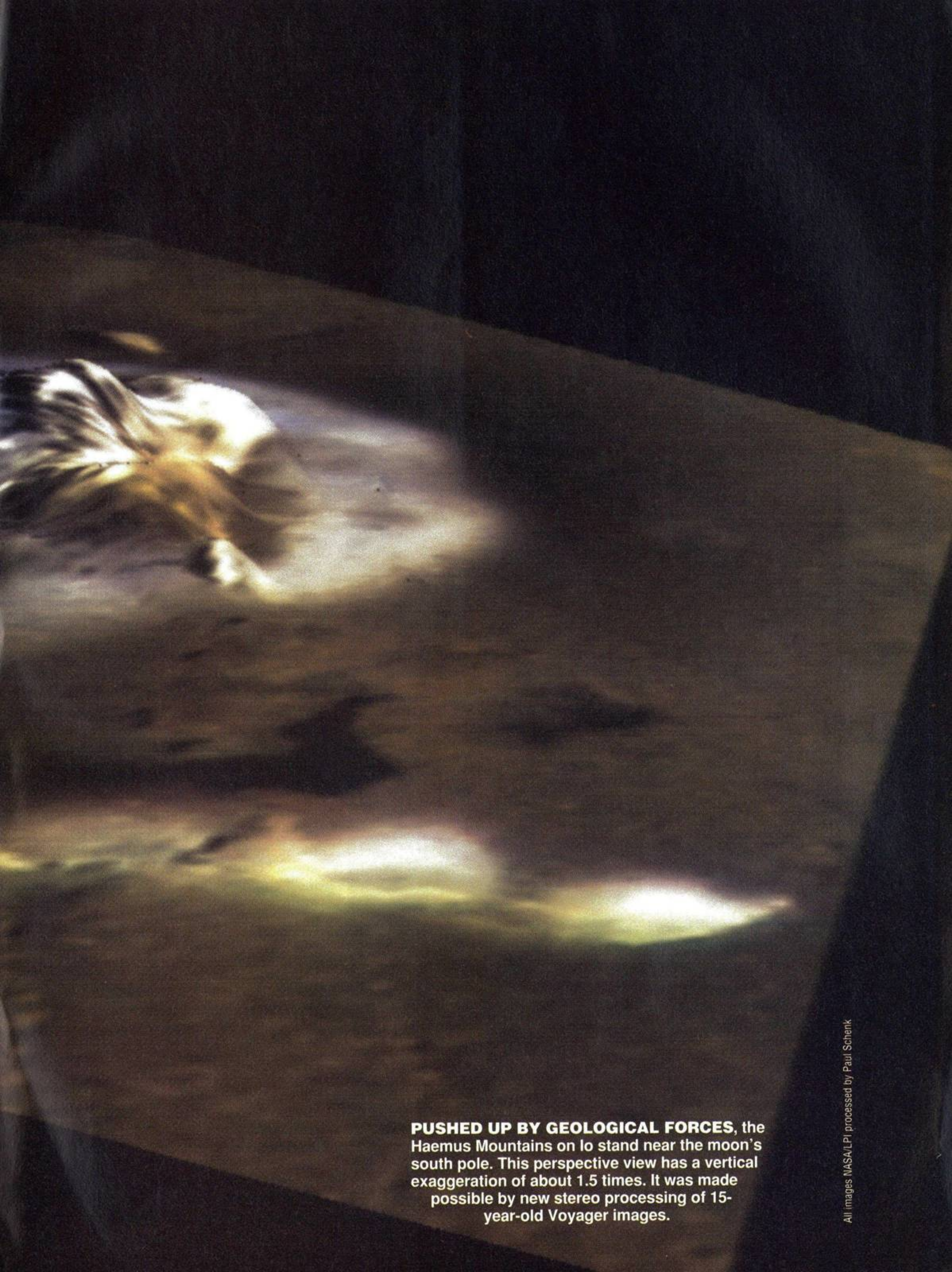
The Mountains of Io

Old Voyager photos meet new computer techniques and bring a better view of the solar system's most geologically active body.

by Paul M. Schenk

A year from now, the first new close-up views in about two decades of Jupiter's moon Io will trickle back from the Galileo spacecraft. Half a billion miles from Earth, Io, the size of our own Moon, has a rocky volcanic surface, noxious atmosphere, sulfurous frosts, and fountains of fiery lava. A scene out of Dante's hell? Actually, Io is a paradise — to a volcanologist.

Volcanos let scientists look inside a planet or moon to see what makes it go. Io is continuously active and scientists have been following its eruptions remotely from Earth (see "The Violent Volcanos of Io," May 1993). Although Galileo's arrival is still a year away, a recent discovery involving images from the Voyager encounters of 15 years ago is giving planetary geologists a "sneak preview" of this Jovian moon.



PUSHED UP BY GEOLOGICAL FORCES, the Haemus Mountains on Io stand near the moon's south pole. This perspective view has a vertical exaggeration of about 1.5 times. It was made possible by new stereo processing of 15-year-old Voyager images.

All images NASA/LPI processed by Paul Schenk

Io is a bizarre world, where huge volcanic plumes arc hundreds of kilometers into the airless sky. These, the only known active volcanos beyond Earth, betray a dynamic interior that's very much alive. Despite the spectacular power driving these explosive eruptions, however, most of Io's extremely young surface has been shaped by quieter extrusions of molten lava.

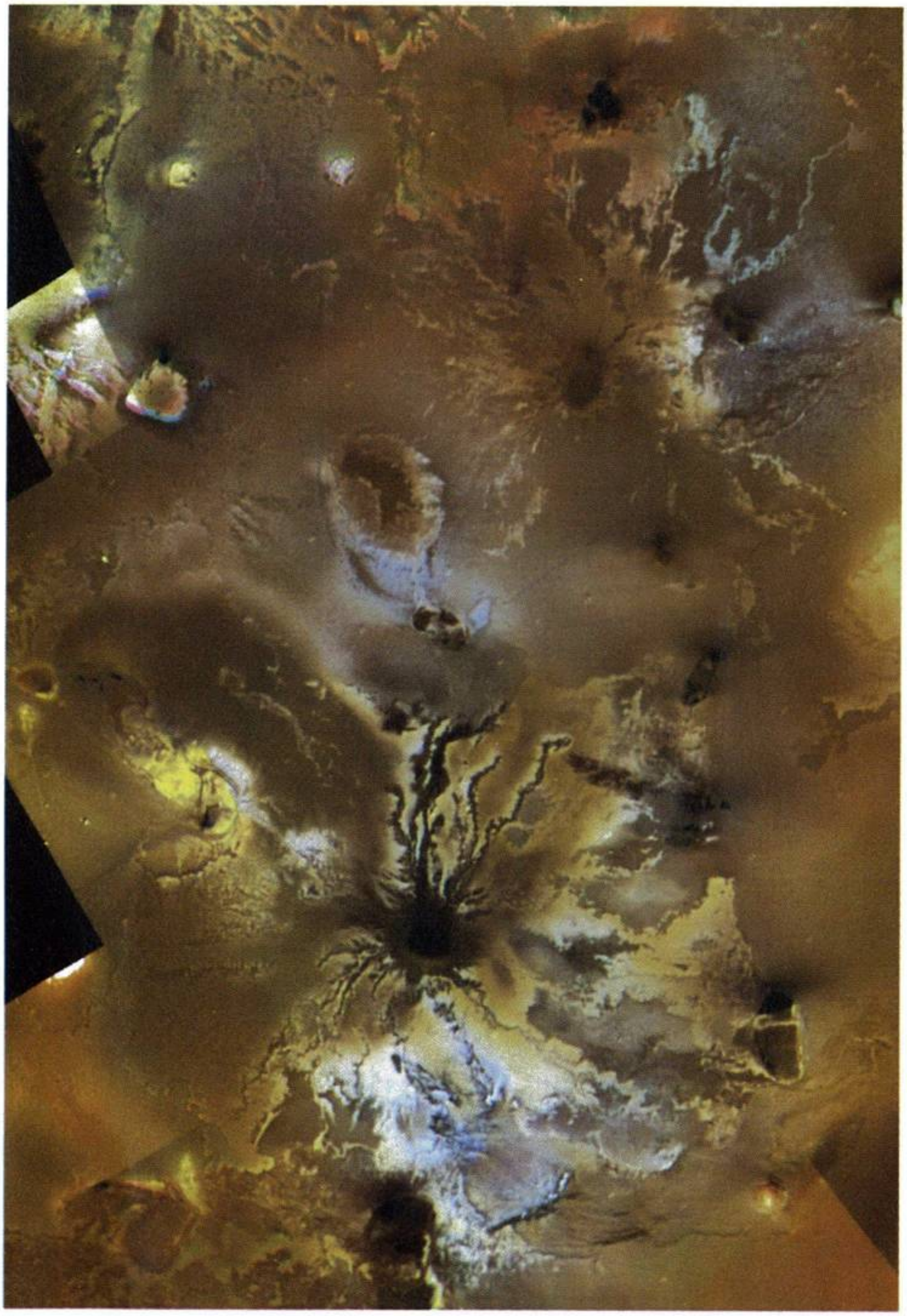
Volcanologists such as myself are drawn to study these features because many of Io's volcanic flows and shallow calderas resemble volcanic structures on Mars and Earth. In some ways familiar to us, Io's features also show major differences. Huge volcanic piles, like Olympus Mons on Mars, are absent. Io's active volcanos spew sulfur and sulfur dioxide, which color the surface pale yellow and orange. Io's lava flows often have bright frosts associated with them because the sulfurous vapor rapidly condenses in the icy vacuum. While Io's size and density resemble those of Earth's Moon, the bright yellowish frosts, extensive sulfur-coated plains, and ongoing volcanic activity say that Io is fundamentally different.

It's easy to compile a list of questions about Io. How long do eruptions last? Are the lava flows molten silicate rock like the dark basalts of the lunar maria, Kilauea in Hawaii, or the Columbia River gorge? Or are they made of sulfur compounds in some way related to the plumes? Does flow composition change with time? What is Io's crust made of?

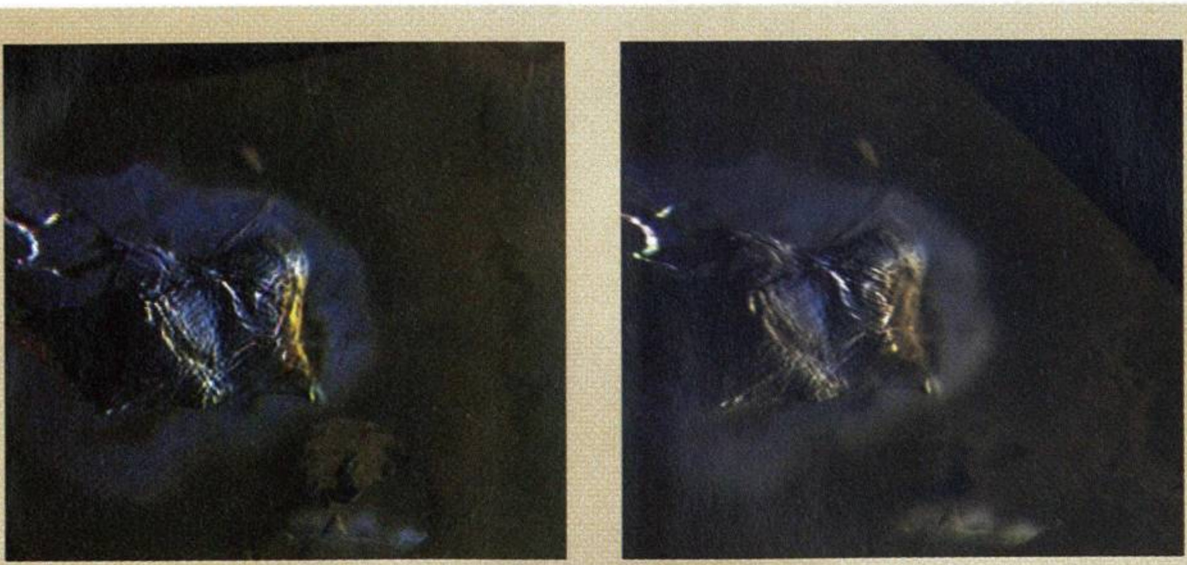
But answers aren't so easy to come by. A few mountains appear to rise abruptly from the surrounding featureless plains. This indicates that Io is at least partly composed of stiff rock rather than weak sulfur, which would flatten out under the weight. But we do not know how these mountains relate to the volcanos or the plumes or how they came to be so high. Detailed maps of Io's composition must await the arrival of Galileo. For the past year, however, I have been studying Io's topography using old Voyager data to learn about its crust.

It's tougher than you think to extract topography from a photo of a planetary surface. On some, the play of light and shadow betrays topography clearly. While this works for a few locations on Io, the extremely complex patterns of albedo and color intrinsic to Io's surface make it very difficult in most areas. This is where stereo imaging can literally change our perception of a planet. Humans use stereo vision to navigate in daily life. Your eyes view the scene in front of you from two slightly different perspectives; the brain combines the two images and instantaneously maps the relative displacements, or parallax, of objects, creating a stereo model of the scene in your head. We do it easily and subconsciously, but it's one of the most complex operations the brain performs.

For geologists studying Earth, stereo aerial photography is a key mapping tool. But until last year, planetary scientists were unaware that usable stereo images of Io even existed. Both Voyager spacecraft flew past Io too far away to take stereo views in the conventional sense. However, when Voyager 2 passed within 25,000 kilometers of Io in



LOW RELIEF AND RUNNY LAVA characterize Ra Patera, a large shield volcano at bottom center. The multicolored flows (some 300 km long) make interpreting the landscape using traditional methods of sunlight and shadow very difficult.



TOPOGRAPHY STANDS OUT BOLDLY with stereo imaging. Pairs of photos like these let scientists map the landforms of Io in great detail. The elevations revealed by stereo imaging can be then processed to yield 3-D views of the feature from any perspective.

This pair of photos shows Haemus Mons in stereo relief. Folding stereo viewers, often available in college bookstores, make seeing stereo images easy. But you can also see the effect without one. Hold a piece of cardboard upright between the pair of images and illuminate both sides equally. Look down with one eye on each side of the cardboard, and relax your eyes until the two images fuse into one.

July 1979, its view of the moon changed rapidly over the course of about three hours, from an equatorial to a polar view. Images from these radically different perspectives yield spectacular stereo views of the surface. From these, we can now measure the height of many of Io's volcanos and map the global distribution of its mountains for the first time.

The most prominent volcanic landforms on Io are the so-called shield volcanos, created when multiple long, narrow lava flows radiate outward from a central vent, building a broad cone-shaped edifice. Many of Io's shields resemble the flows flanking terrestrial volcanos, such as Mt. Etna in Sicily.

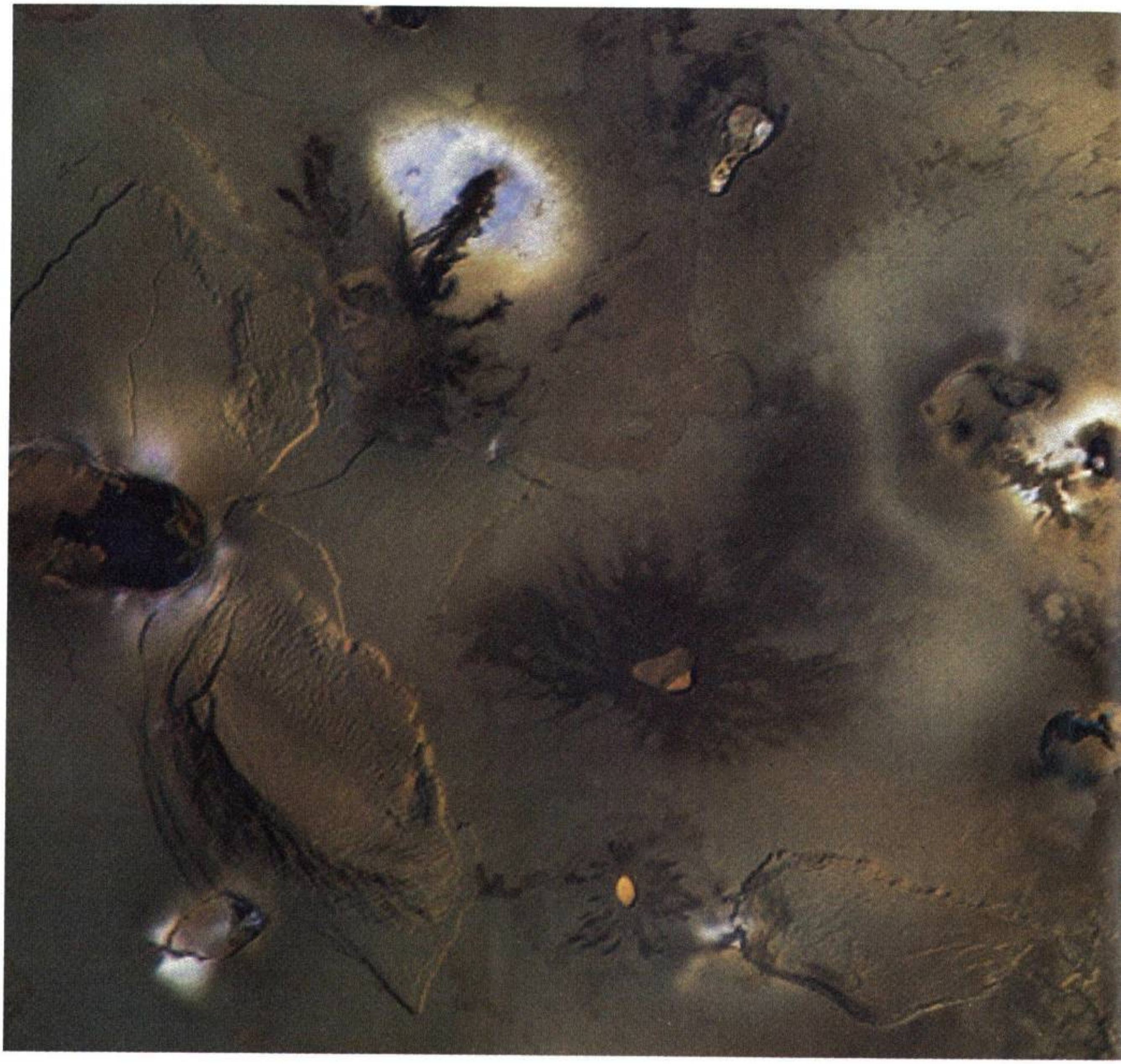
Ra Patera is a typical Ionian shield volcano. At least a dozen dark flows, up to 300 kilometers long, radiate from a single dark vent. The yellow and orange colors and lengths of these flows suggest that they could be composed of sulfur. Stereo images reveal that the central part of Ra Patera is only 2 to 3 km higher than the surrounding plains; the average surface slopes a little less than 1°. These contrast with other large volcanos in the solar system such as Hawaii's Mauna Loa (height 9 km) which has slopes averaging 6°, Mt. Fuji (4 km) with 25° slopes, and the great Tharsis volcanos on Mars which have slopes of 3° to 15° and heights up to 23 km.

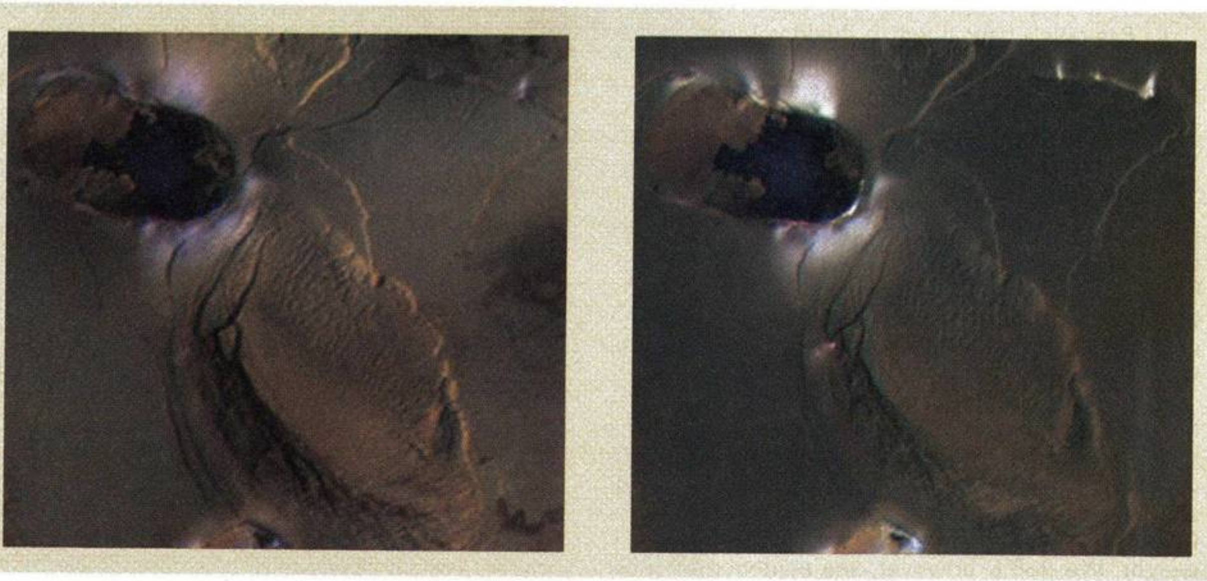
But maybe the slopes are misleading. It's possible that Ra Patera was originally much higher and steeper but that the warm interior of Io is so soft that the crust gave way under the weight. Hawaii's volcanos are actually twice as thick as they appear because the ocean floor has subsided several kilometers due to their weight. We don't, however, see evidence of subsidence, such as fracturing or warping, in the area around Ra Patera.

The relatively flat slopes of Ra Patera suggest that its lavas, compared to most terrestrial basalts, were very fluid: a consistency like that of slightly chilled molasses. Does this mean they are composed of sulfur? It's difficult to say — basaltic lavas on the lunar maria traveled for several hundred kilometers on slopes even shallower than those on Ra Patera. The flows on Ra could be composed of basalt similar to the lavas that formed Mauna Loa. One way to get long flows with molten basalt is to heat it to high temperatures or load it with iron or magnesium. A high iron content in Ionian lavas, if confirmed, would have important implications for Io's bulk internal composition. Conceivably, these may have been very-low-silica lavas, such as carbonatite or even sodium sulfide.

While humans can usually get out of the way of most lava flows, the Ra flows may have been very fast indeed — perhaps like an unusual Hawaiian flow of 1801 that traveled at almost 30 miles per hour. Some flows in other areas of Io have a thicker, more massive structure, indicating they were rather viscous, like raspberry jam. Unfortunately, Voyager saw few flows of this type in stereo.

The most prominent topographic feature in the Ra Patera region is a complex flow-like ridge structure extending some 500 km to the east and north. This distinctive deposit is several hundred meters thicker than any of the narrow ribbon-like flows. Within this flow the stereo imagery also reveals a prominent peak more than 4 km high just north of a small volcanic pit or caldera, which clearly must have formed later. Parts of





this complex flow appear to be eroded, suggesting it may be relatively old. This implies the material extruded from Ra Patera underwent a radical change either in composition or temperature.

Landslides occur on many planets and Io is no exception. The largest lies at the base of Euboea Montes, an unusual mountain 9 km high and over 250 km long. The western face of the mountain is a smooth, uniform surface tilted at 10°. A hummocky, ridged deposit a little over 2 km thick lies at the base of the slope and extends outward some 70 km. There's no evidence this deposit is volcanic. Rather, stereo images support the idea that Euboea Montes is a block of Io's crust that was pushed upward at least 9 km and tilted to one side. The hummocky material apparently slid off the top of the block toward the northwest, forming a chaotic mass at its base. It is among the largest landslides in the solar system.

What forced this massive block upward is a mystery, but Euboea Montes may reveal something about the internal makeup of Io. The upper crust may be layered, with a thin, weaker layer overlying a stronger one. Asked to speculate on the composition of the weak layer, I might suggest that it could be a thick accumulation of ash from the plumes or perhaps interbedded lavas of different compositions, including sulfur.

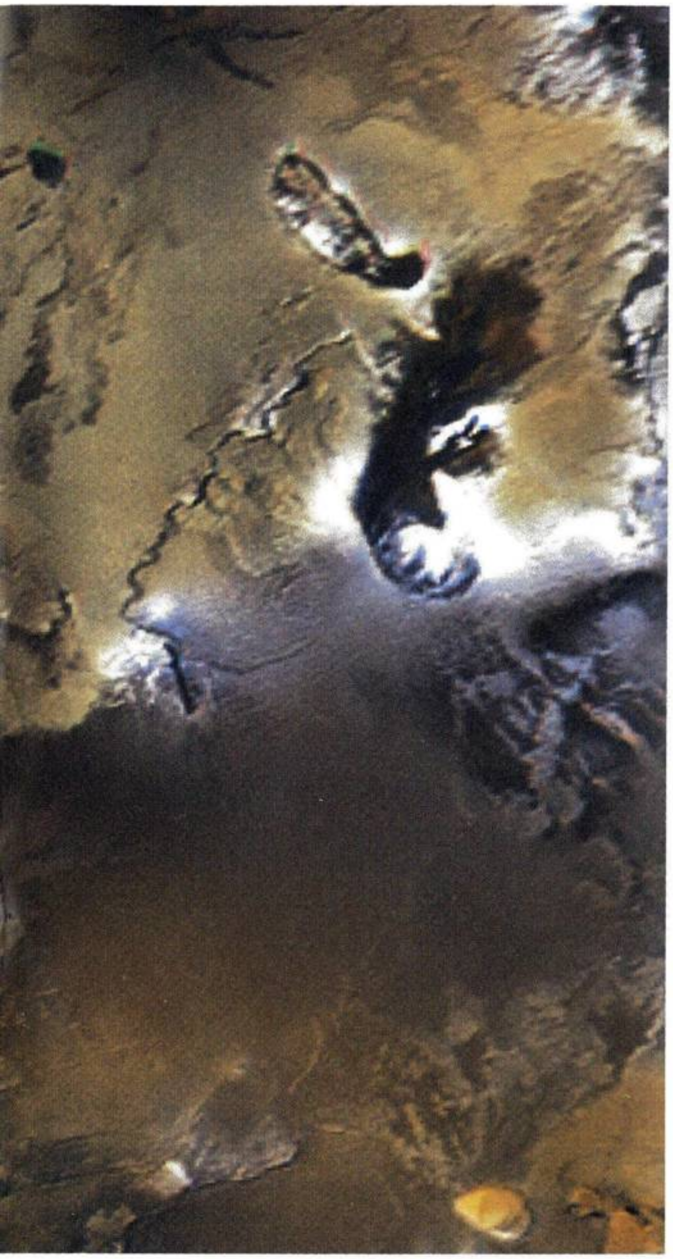
Another unusual feature of interest is Loki Patera, a large horseshoe-shaped dark spot just south of Loki, a prominent volcanic plume. In 1979 Voyager discovered that Loki Patera is a thermal hot spot and it continues to be hot even today. One scenario has proposed that the dark spot is actually the surface of a molten sulfur lake, and the small polygonal bright features within it are "lava-bergs" floating in the lake.

The highest resolution images of Loki Patera reveal no topography at all. By using a slightly lower resolution but oblique image together with the better images, we have discovered that a wall or scarp a few kilometers high forms the northwest shore of the lake. (The scarp eluded detection in the best images as they were taken from almost directly overhead.) The scarp coincides with the fallout zone from the main Loki plume. Apparently, Loki Patera has eroded or cut into a considerable thickness of ash and debris deposited by the Loki plume.

Although the dark spot could be a lake of molten sulfur or silicates, Loki's cliffs suggest the surrounding plains at least are composed of stiffer silicate-rich materials more common on Earth. Sulfur is a very weak material compared to most rocks and by itself couldn't support the wall surrounding the lake.

These stereo images can reveal many new features of Io's geology and history but cannot in themselves answer the most fundamental questions. They have, however, revealed processes such as landslides and have helped us map the dimensions of major geologic features and let us constrain the physical properties of Io's lavas. These can be extremely fluid or rather sticky, a range of flow properties that is consistent with a terrestrial-like silicate interior yet allows for significant sulfur (or other) volcanism.

When Galileo finally arrives, the search will be on for these and even more exotic compositions. ☐



Landslide at Euboea Montes

Untangling the effects of topography, lighting, and surface color can be difficult on Io. Euboea Montes (at left edge, above) stands about 9 kilometers high and extends 250 km. The back side of the mountain slid off toward the top of the frame, leaving the slide area with a "rumpled" surface. The oval on the left edge is a caldera depression partly filled with dark lavas.

Paul M. Schenk is a planetary scientist at the Lunar and Planetary Institute in Houston.

MEADE'S ONLY AUTHORIZED EAST COAST APD MAIL-ORDER DEALER

YOUR #1 SOURCE

focus cam

INFORMATION HOTLINE 718-436-6262

MEADE ADVANCED PRODUCTS

LX200 SCHMIDT-CASSEGRAINS

8"/10"/12" CALL NOW!!!

NEW TECHNICAL ADVANCES FOR 1994

18-volt Dual Axis Drive Systems: LX-200 motor torques are increased by about 60% • **Ultra Reliable Electronic Systems:** The most trouble-free serious telescope ever manufactured • **New Version 3.20 Software:** Quick (less than 10 seconds!) 2-star alignment • **Software Library Options:** Library option 1 - 10,600 & library option 2 - 64,350 • **PC-Interface Capability** (w/Astro Search 200): Point and click on any of 45,000 planetary, deep space, or stellar objects • **Contrast Enhancing Fields Stops:** Significantly increase lunar, planetary, and deep space image contrast • **Legendary Meade Super Multicoated (EMC) Optics:** The finest SC optics available, optics that yield razor sharp stellar images & high resolution observing of the moon, planets, and deep space • **Heavy-Duty Fork Mounts:** The largest, most rigid in the industry, complemented by large 4" diameter polar ball bearings & by DC servo motor-driven worm gears on both telescope axes • Four-Speed Drives on Both Telescope Axes' • **Digital Readouts:** On both axes, read from the keypad hand controller • **Go to Capability:** Enter the RA & Dec of an object into the keypad hand controller, press GOTO and the telescope slews at up to 8°/second, centering it in the field • **747 Built-in Object Library** • Permanently Programmable Smart Drive.

8" WEDGE
$110
10"/12"
SUPER WEDGE
$396
OBJECT LIBRARY #1
10,600
CelestialObjects
$99
OBJECT LIBRARY #2
64,350
Celestial Objects
$149
ASTROSEARCH/200
$99.95

YOUR CHOICE
F/6.3 OR F/10
SCT OPTICS

LX2008"
$2495

LX200 10"
$2895

LX200 12"
$3995

LX200 16"
CALL

STARFINDER EQUATORIAL

- **Superb Optical System**
- **Precision Equatorial Mount**
- **Electronic Motor Drive**

STARFINDER 6 6" F/8	**$599.95**
STARFINDER 8 8" F/6	**$699.95**
STARFINDER 10 10" F/4.5	**$799.95**
STARFINDER 16 16" F/4.5	**CALL**
4500 NEWTONIAN	**CALL**

STARFINDER ACCESSORIES

#47M Dual Axis Drive Corrector	**IN STOCK!**
Dust cover for Starfinder 6/8/10	**29.95**
#43 Drive Corrector	**88.50**
55 Dec.	**79.95**

PICTOR SERIES CCD IMAGERS

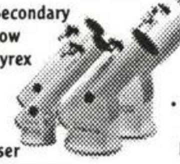
NEW

For the beginner, or for the most advanced observer, the real CCD revolution is here!

All models, including the least expensive unit, are simple to use. And yet, because state-of-the-art Meade electronic & software design, this simplicity is accomplished simultaneously with the most advanced CCD image resolution and performance in the history of amateur astronomy.

#201 Autoguider/Imager	$395
#208 Autoguider/Imager	$795
#216 Autoguider/Imager	$1195
#416 Autoguider/Imager	$2495
#1616 Autoguider/Imager	$6995
#616 Color Filter System	$695

NEW DOBSONIANS



- **Primary & Secondary Mirrors of Low Expansion Pyrex Glass**
- **Precision Rack-and-Pinion Focuser**

Rigid, Durable, Beautiful Dobsonian Mountings

- **Fully-Adjustable 4-Vane Secondary Mirror System**

DOBSONIAN 6" F/8	$295
DOBSONIAN 8" F/6	$395
DOBSONIAN 10" F/4.5	$565
DOBSONIAN 12.5" F/4.5	$765
DOBSONIAN 16" F/4.5	CALL

ED APOCHROMATIC REFRACTORS

American made ED Apochromatic refractors feature an f/9 doublet design

152ED 6 Inch F/9	**4495**
127ED 5 Inch F/9	**2795**
102ED 4 Inch F/9	**2195**
178ED 7 Inch F/9	**5495**
#1664 Elect. Drive	**369**
#1697 Computer Drive	**695**
285 60mm Equatorial Refractor	**309**
390 90mm Altazim. Refractor	**CALL**
395 90mm Equatorial Refractor	**CALL**
227 60mm Altazim. Refractor w/2 1¼" Oculars	**CALL**

SPOTTING SCOPES

- **3½"1000mm F/11 optics**
- **5x21 erecting image finder**
- **45° erecting diagonal**
- **40x Meade eyepiece**

MULTICOATED OPTICS LIFETIME WARRANTY

97E with Case	**332.95**
97ER Rubber Armored	**359.95**
2045S 4" SPOTTING SCOPE	**SPECIAL**
Carry Case for 97 E Series & 2045S	**49**

STANDARD SERIES SCHMIDT-CASSEGRAINS

2045D "The truly portable scope"	**CALL**
Case for 2045D75Tripod & Wedge	**234**
Piggyback Bracket for 2045D	**15.95**
2080A "Perfect for the beginner"	**CALL**
2080B with SMC multicoatings	**CALL**
2120A "The best value 10" SCT"	**CALL**
2120B with SMC multicoatings	**CALL**
LX100R 8" NEW!	**CALL**
LX100 10" NEW!	**CALL**
8" Wedge	**110**
10" Wedge	**250**
#1205 Controller	**CALL**

IN STOCK FOR SAME-DAY SHIPPING!

EYEPIECES

SERIES 4000 SUPER PLÖSSLS

Meade Super PlÖssls are the finest general-purpose eyepieces available. All Multi-Coated

Super Plossls (SP; 4-elements: 1.25" 52°)

6.4, 9.7, 12.4, 15, 20, 26mm	**87.95**
32mm, 40mm	**109.95**
56mm (2")	**229.95**

SERIES 4000 SUPER WIDE ANGLE

Super Wide Angle (SWA; 6-elements: 1.25" 67°)

13.8mm	**159.95**
18mm	**169.95**
24.5mm	**199.95**
32mm (2")	**279.95**
40mm (2")	**339.95**

SERIES 4000 ULTRA WIDE ANGLE

The Ultimate Eyepieces; Extreme Image Sharpness Over an Amazing 84° Field.

Ultra Wide Angle
(UWA; 8-elements: 1.25" 84°)

4.7mm	**179.95**
8.8mm (1.25"/2")	**269.95**
6.7mm	**219.95**
14mm (1.25"/2")	**329.95**

ILLUMINATED RETICLE EYEPIECES

	SERIES 4000 PLÖSSL 9mm 1.25"	MA 12mm 1.25"
Without Cord	**149.95**	**99.95**
With Cord	**129.95**	**79.95**

BARLOW LENSES & ACCESSORIES

#122 Doubles eyepiece power with sharp, high resolution, high contrast imaging on telescopes of all types. 27mm dia. Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multicoated 1.25" **47.95**

#127 Precision internal sliding lens assembly permits continuously variable power settings between 2x & 3x. Engraved scale indicates power in use. Yields bright, sharp, high contrast images, on telescopes of all types. Multicoated 1.25" **59.95**

#126 Only 2.5 inches long, works well with any telescope excepting 1.25" eyepieces, even though with limited focus range. Multicoated 1.25" **47.95**

#140 2x Apochromatic The most advanced barlow lens available for commercial telescopes; includes 3-element, air spaced optics, multicoated **79.95**

Camera Adapter .965"	**27.95**
1.25"	**29.95**
Variable Projection Camera Adapter 1.25"	**39.95**
Basic Tele-Extender	**29.95**
Variable Tele-Extender	**39.95**
T-Adapter for SCT's	**26.95**
#927 45° Erect Image Diagonal Prism .965"	**49.95**
#928 45° Erect Image Diagonal Prism 1.25"	**49.95**
#929 2" Diagonal Mirror	**99.95**
#931 Hybrid: Excepts 1.25" eyepieces, Fits .965" Focusers	**49**

FILTERS

Series 4000 Nebular Filters 1.25"

Premium multilayer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high contrast observing of faint nebulae.

Broadband Filters

#908B	**79.95**
#910B	**119.95**
#911B9	**99.95**

Narrowband Filters

#908N	**89.95**
#910N	**129.95**
#911N	**119.95**

Series 4000 Photo-Visual Color Filters 1.25"

Made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Fully coated. #8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue ...... @**14.95**

Moon Filter #ND96 Reduces brightness by 87%	**16.95**
Set #1 4-Filters: #12, #23A, #58, #80A	**54.95**
Set #2 4-Filters: #11, #25A, #47, #82A	**54.95**
Set #3 4-Filters: #8, #21, #38A, #56	**54.95**

FREE! MILLER PLANISPHERE WITH EVERY SCOPE ORDER

WHILE SUPPLIES LAST

era & video

FOR ORDERS ONLY CALL 800-221-0828

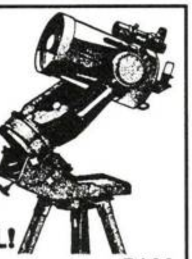
CELESTRON

C8+/C8+ COMPUTERIZED

The C8+ and C8+ Computerized are the newest in the C8 family of 8" f/10 Schmidt-Cassegrain telescopes. Their design is sophisicated yet simple and fun to use. No complex bells or whistles to slow you down or interfere with operation. Set-up is quick with your C8+, leaving you time to enjoy yourself and your observing.

CLOSE OUT!

ULTIMA 8 PEC



The Ultima 8 PEC was completely redesigned to provide unsurpassed optical excellence, with superior mechanical and structural stability. A rugged highly damped mount makes viewing and astrophotography a delight. Ergonomic user-friendly operation is the trademark of the Ultima 8 PEC. **SPECIAL!**

GG-11 .... **CALL**

NEW

ULTIMA 2000 8" & 11"

The Ultimate in Simplicity & User Friendliness
Built-in Optical Encoders • 4-motor Slewing
RS-323 Port • Autoguider Ready
CCD Compatible • Portable and Rigid
CALL

C5/C5+

SPECIAL!

For astronomy on the go, the C5 can't be beat. Extremely portable, fits virtually anywhere from a compact car trunk to most airline overhead compartments. A serious, high quality precision instrument. The C5 was chosen by NASA for several recent shuttle missions.

FILTERS

Eyepiece Filters 1-1/4" - #1A, #8, #12, #15, #21, #23A, #25, #38A, #47, #56, #58, #80A, #82A, #96ND-50%T, #96ND-25%T, #96ND-13%T, Polarizing .... **CALL**

PRECISION SOLAR FILTERS MOUNTED
by Thousand Oaks Optical

2	**61.90**	3.1"	**64.90**	4¼"/5"	**95.9**	6"	**104.90**
8"	**124.90**	10"	**138.90**	1 1"	**148.90**	12.5"/13.1"	**179**

beattie INTENSCREENS

- **Increased Brightness**
- **Easier to Focus**

CALL

TOP EAST COAST DEALER
WE'LL MEET & BEAT ANY LEGITIMATE PRICE!

NEWTONIANS

NEW! GP-C200 f/4 7.9" Reflector	**IN STOCK!**
C4.5 4-1/2" (114mm) aperture telescope	**459**
NEW! Firstscope 114 (41/2") Reflector	**CALL**

REFRACTORS

GP-C102	**CALL**	GP-C102F	**CALL**
Firstscope 80 78% Brighter than 60mm scopes			**CALL**
Firstscope 60 **NEW!**			**128.95**

ACCESSORIES

Barlow Lens 2x 1.25"			**62.95**
Counter Weight Bar Assembly 8"59	**95**	11"	**64.95**
DEC Motor f/#93516129DEC Motor f/Classic			**889**
DEC Motor f/C5+99.95DEC Motor f/C8+			**124.95**
DEC Motor f/PEC's129.95Diag. Mirror Star 2"			**179.95**
Diagonal Star 1.25" w/Multicoatings			**44.95**
Digital Setting Circles - Advanced Astro Master			**CALL**
Drive Corrector Heavy Duty			**394.95**
Expanding Bushing .96" to 1.25"			**49.95**
Finderscope 7x50	**159.95**	Focusmotor f/PEC's	**139.95**
MFFT-55	**134.95**	Micro Guide Eyepiece	**159**
Motor Drive f/C4.5	**174.95**	Motor Drive f/GP/SP	**269**
Multiple Holder 1.25"	**145**	Visual Back 1.25"	**52.95**
Photo Tripod Adptr	**CALL**	Piggyback Mount 8"	**34.95**
Piggyback Bar Assembly 11"			**64.95**
Polar Axis Finder	**89.95**	Radial Guider	**114.95**
Radial Guider f/C5	**119.95**	Reducer Corr. f/6.3	**119.95**
Reducing Bushing	**49.95**	Shoulder Mount	**79.95**
Tripod 8"	**259.95**	Tripod, Mini	**34.95**
Vibration Suppression Pads			**49.95**

EYEPIECES

PLÖSSL 1-1/4"

7.5mm	**CALL**	10mm	**CALL**	17mm	**CALL**
26mm	**CALL**	40mm	**CALL**		

ULTIMA SERIES

5mm 1¼"	**CALL**	7.5mm 1¼"	**CALL**	12.5mm 1¼"	**CALL**
18mm 1¼"	**CALL**	24mm 1¼"	**CALL**	30mm 1¼"	**CALL**
35mm 1¼"	**CALL**	42mm 1¼	"**CALL**	60mm 2"	**CALL**

Tele Vue®

"Tops in the Field"

NEW PANOPTIC *Tack Sharp*

15mm 1¼"	**CALL**	22mm 1¼"/2"	**CALL**
27mm 2"	**CALL**	35mm 2"	**CALL**

NAGLER Spacewalk Experience

NOW... BY POPULAR DEMAND!

12mm Type 2 1¼"/2"	**CALL**		
16mm Type 2 1¼"/2"	**CALL**		
20mm Type 2 2"	**CALL**		
4.8mm 1¼"	**CALL**	7mm 1¼"	**CALL**
9mm 1¼/2"	**CALL**	13mm 1¼"/2"	**CALL**

PLOSSL

7.4mm 1¼"	**CALL**	10.5mm 1¼"	**CALL**
13mm 1¼"	**CALL**	17mm 1¼"	**CALL**
21mm 1¼"	**CALL**	26mm 1¼"	**CALL**
32mm 1¼"	**CALL**	40mm 1¼"	**CALL**
55mm 2"	**CALL**		

WIDEFIELD

15mm 1¼"	**CALL**	19mm 1¼"	**CALL**
24mm 1¼"	**CALL**	32mm 2"	**CALL**

GENESIS-SDF KIT
Sky Tour Observing System **CALL**

PRONTO 70mm, E.D. Doublet, 480mm, f/6.8

Pronto w/2" Star Diag. 70mm f6.8 ED Glass & 21mm Plossl	**CALL**
Pronto with Amici Prism & 21mm Plossl	**CALL**

BINOCULARS

CELESTRON

HOW TO CHOOSE BINOCULARS			**6.95**
7x42 Ultima	**189**	7x50 Ultima	**249**
8x32 Ultima	**185**	8x56 Ultima	**279**
10x42 WA Ultima	**225**	10x50 Ultima	**259**
11x80 MC.	**299**	15x80 MC	**319**
20x80 MC.	**329**	9X63 Pro	**205**

CELESTRON SPOTTING SCOPES

C90 All Models Including 1.25", C5 5", 500/5.6, C8	**CALL**

SWAROVSKI OPTIK

SPOTTING SCOPES

AT-80	CALL	ST-80	**CALL**
AT-80 HD (Angled)			**CALL**
ST-80 HD (Straight)			**CALL**
CT-75	CALL	CT-85	**CALL**

EYEPIECES

ATO-20-60x	**CALL**
ATO-15x & 22x	**CALL**
ATO-33WWX	**CALL**

SLC SERIES

NEW! B7x30B MKIII	**CALL**
NEW! B8x30 WB MKIII	**CALL**
B7x42 WB Blk, Grn	**CALL**
B8x30W MKII Grn	**CALL**
B10x42 WB Blk, Grn	**CALL**

FUJINON

6x30 FMTR-SX Rubber Armored	**341.95**
7x50 FMT-SX w/carry case	**372.95**
7x50 FMTR-SX Rubber Armored	**415.95**
7x50 FMTRC-SX Armored w/compass	**472.95**
8x30 FMTR-SX Rubber Armored	**339.95**
10x70 FMT-SX w/carry case	**470.95**
16x70 FMT-SX w/carry case	**520.95**

Nikon® SPORT OPTICS

You'll never see things quite the same again.

STAYFOCUS PLUS SERIES

7x35 RC	**89**	7x50 RC	**109.95**	10x50 RC	**110**

CRITERION SERIES

7x35 E	**259**	8x30 E	**275**	10x35 E	**309**
10x70 IF	**699**	10x70 HP IF	**899**		
10x50 Lookout					**109.95**
7x50 IF SP Prostar WP					**689.95**

SPOTTING SCOPES

Fieldscope ED II Body W	**540**
Fieldscope ED II Angled Body W	**599**
Fieldscope ED II 78mm	**919.95**
Fieldscope ED II 78mm Angled	**979.95**

BUSHNELL
SPACEMASTERS

Spacemaster	**138.95**
Spacemaster Kit w/15-45 Zoom Eyepiece	**238.95**
Spacemaster ED Glass	**293.95**
Armored Spacemaster	**157.95**
Armored Spacemaster Kit w/15-45 Zm Eyepiece	**254**
Discoverer	**172.95**

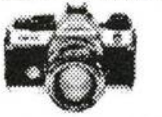
MANUAL CAMERAS

Nikon FM-2

- You are in Command
- 3-Point LED Exp. Display
- Nikon Performance & Durability

$449

OLYMPUS OM-4T



- Manual aperture & shutter control
- Titanium housings for increased ruggedness, decreased weight

CALL

PENTAX K1000

- Full Manual control
- ISO 20 to 3200 film speed range

$174.95

Nikon N6000 Body	**359.95**	F-3HP Body	**CALL**
Canon F-1 Body	**CALL**	Contax S2 Body	**CALL**
Leica R6.2 Body	**CALL**	Pentax LX Body	**CALL**

FILM

KONICA		KODAK	
SRG 3200 24 Exp.	**6.25**	TMZ 3200 36 Exp.	**4.50**
SRG 3200 36 Exp.	**7.59**	Royal Gold RF 1000 24Exp.	**5.73**
SR 100 36 Exp.	**2.69**	Royal Gold RF 1000 36Exp.	**7.29**

THESE ADVERTISED PRICES ARE VALID NOV. 1 - NOV. 30, 1994 SUBJECT TO PRODUCT AVAILABILITY
ORDERS ONLY CALL 800 221-0828 • INFORMATION & NY STATE CALL (718) 436-6262
ORDER STATUS & CUSTOMER SERVICE (718) 871-7608 24 HOUR FAX LINE (718) 871-1152

focus camera, inc. 4419-21 13th Ave., Brooklyn, NY 11219

Orders Shipped Promptly - Most Major Credit Cards, Money-Orders & Personal Checks accepted for payment. COD orders are accepted but may require a deposit, personal checks may require up to 14 days to clear. All orders are subject to verification & acceptance. Shipping handling & insurance are additional, please call/write for exact details. 14-day money back guarantee (less shipping) provided merchandise is returned in new condition, unused as received with papers & packaging intact. **We gladly accept and reply to written or faxed inquiries.** Not responsible for typographical errors. Ad prices available while supplies last. This ad supersedes all previous ads. Hours: Mon-Thurs.. 9-7, Fri 9-2, Sun 10-6.

SKY ALMANAC

Highlights
by Jeff Kanipe

Date	Event
2	Observing Asteroid 654 Zelinda . . . *(p. 62)*
3	First Views: Quadrantid Meteors . . . . . *(p. 59)*
20	Comet Borrelly Reaches Opposition . . . *(p. 63)*
23	The Moon Pairs with Spica. . . . . *(p. 59)*
27	The Moon Passes Venus . . . . *(p. 61)*
all month:	
	Mars Gets Big and Bright . . . . *(p. 54)*
	See also "Discover the Red Planet" . . . *(p. 72)*
	Saturn Owns the Evening Sky . . *(p. 61)*
	Wake Up with Venus . . . . *(p. 61)*
	Observer's Challenge: Jupiter Loses Its Spots . . . . *(p. 62)*
	The Starry Sky: Canis Major . . . . *(p. 60)*

Get ready. Mars is back and it's getting bigger as it approaches opposition. The Quadrantid meteors streak overhead on the 3rd. Saturn and its rings highlight the evening sky while Jupiter's comet crash bruises remain faintly visible in small telescopes.

by Deborah Byrd

It was fun last summer and early fall to watch the two brightest planets — Venus and Jupiter — edge closer together on the dome of the evening sky. By Halloween, both planets were so near the Sun along our line of sight that they were difficult or impossible to see. Venus passed between us and the Sun on November 2, and Jupiter passed behind the Sun on November 17.

Then as always Earth moved on in its orbit around the Sun, bringing Jupiter back into view before dawn. Meanwhile, Venus fled ahead of us in its smaller, faster orbit. Now at greatest elongation it's also up before the Sun. On January 13, Venus' distance from the Sun is 47°, and Venus and Jupiter lie just 3° apart. They are beacons in the predawn sky, a double whammy of brilliance, outshining all the stars.

At greatest elongation, Venus shines at magnitude –4.4. Around the middle of January, it appears through a telescope to be half illuminated, a phase of the planet called "dichotomy." The disk of Venus measures about 25" this month and will shrink in the coming months as the planet continues to speed along ahead of us in orbit.

This month Jupiter shines at magnitude –1.9. As the largest planet in the solar system, it always looms large through the eyepiece of a telescope. Now its disk measures nearly 33" even though it is on the far side of the solar system from Earth. Perhaps some dark crash spots created in the spectacular impact of Comet Shoemaker-Levy 9 last summer will remain visible.

The bright star Spica lies above Venus and Jupiter in the predawn sky. Be sure to watch on January 23, when the Moon sweeps only 0.6° north of Spica. Yet another bright star — Antares in the constellation Scorpius — lies below Venus and Jupiter this month. Venus passes 8° north of Antares on January 15,

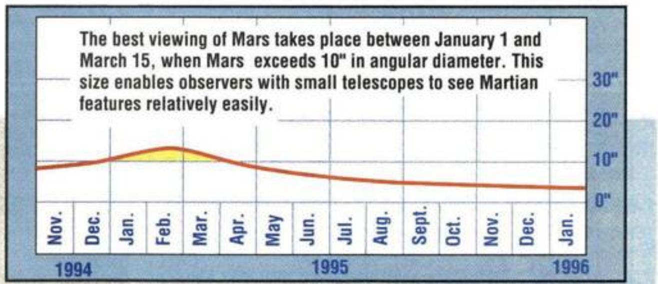
Mars Gets Big and Bright

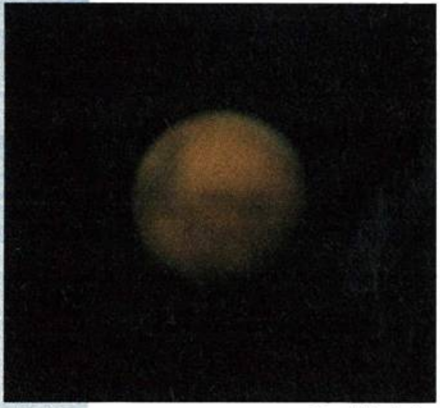
Mars has been a minor player in the planet kingdom for over a year now, keeping to the morning sky and remaining fairly inconspicuous. But beginning this month the Red Planet begins to take center stage. In fact, we can see Mars in the evening sky now, glowing like a dull red coal through the bare trees to the southeast. To some ancient civilizations, Mars had ominous connotations (blood, death, the bringer of war, and all that apocalyptic stuff), but to the modern amateur astronomer, its appearance in the east shortly after sunset can mean only one thing: The planet is approaching opposition, which is the most favorable time to scrutinize this world in a telescope.

This month, Mars' equatorial diameter swells from 10.8" on January 1 to 13.5" by month's end. Its magnitude increases from –0.3 on January 1 to –1.1 on January 31. It is only 0.1 magnitude brighter at opposition on February 11. This is as bright and as large as Mars gets this year.

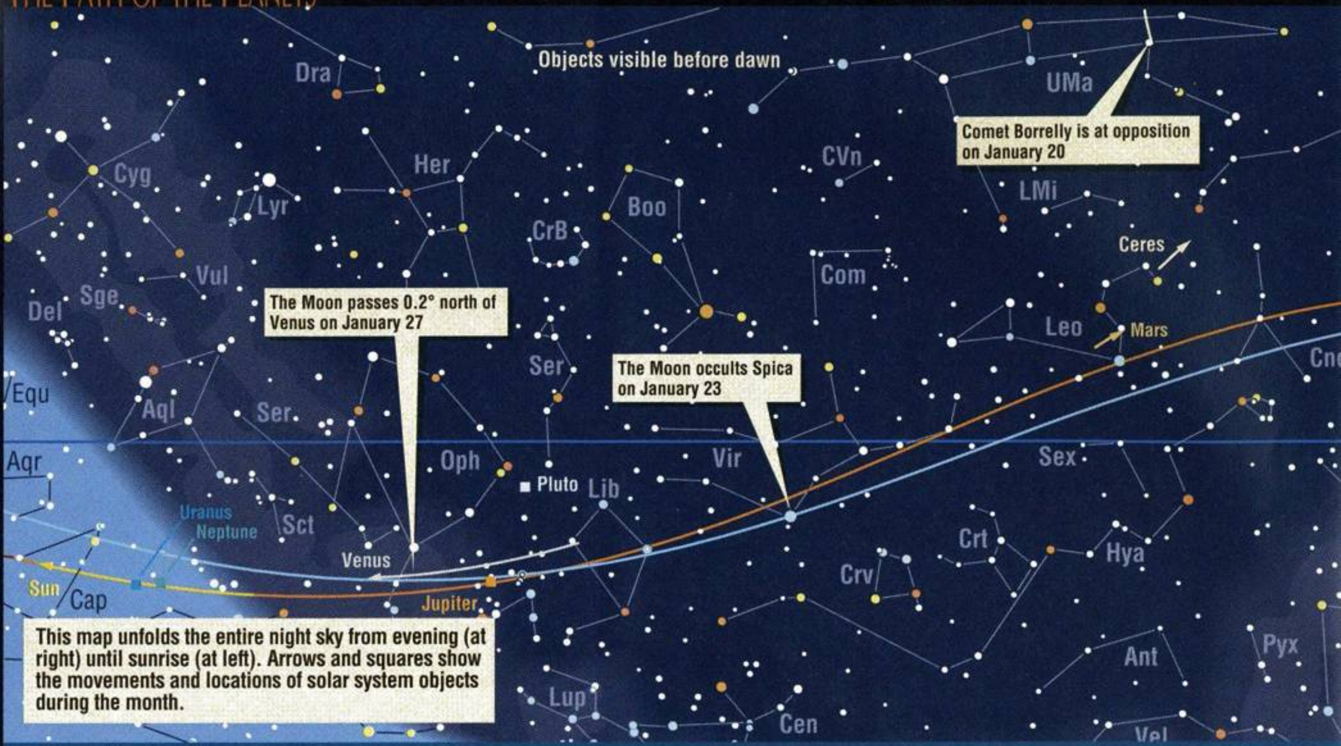
Mars is the only planet on which permanent surface markings (not shifting atmospheric features) are visible in telescopes. On a clear steady night around the time of opposition, any telescope at moderate magnification can resolve the major albedo features, like the wedge-shaped plain Syrtis Major, the bright circular dust bowl known as Hellas Basin, which lies south of Syrtis Major, the dark, irregular oval Meridiani Sinus, and the arch-shaped Sabeus Sinus.

Unfortunately, the planet's apparent diameter is not as large this go-round as it has been during recent oppositions, so these features are less prominent than they could be. Thus, the planet dwindles in apparent size over the next few months.


The best viewing of Mars takes place between January 1 and March 15, when Mars exceeds 10" in angular diameter. This size enables observers with small telescopes to see Martian features relatively easily.


Donald C. Parker

THE PATH OF THE PLANETS


Dra
UMa
Cyg
Lyr
Her
CVn
LMi
Boo
CrB
Ceres
Vul
Com
Del
Sge
Leo
Mars
Cn
Ser
Equ
Aql
Ser
Oph
Sex
Aqr
Pluto
Lib
Vir
Uranus
Neptune
Sct
Venus
Crt
Hya
Crv
Sun
Cap
Jupiter
Pyx
Ant
Lup
Cen
Vel

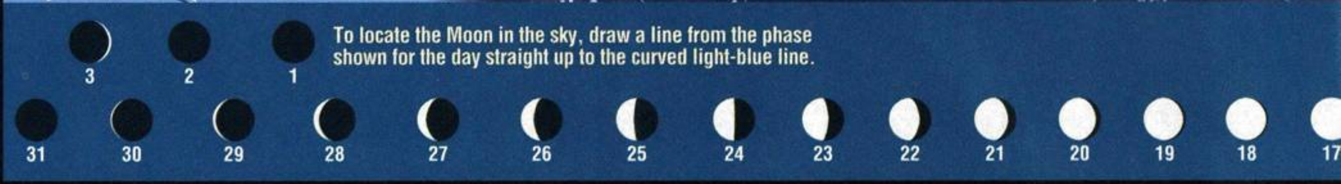
Objects visible before dawn

Comet Borrelly is at opposition on January 20

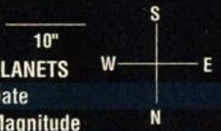
The Moon passes 0.2° north of Venus on January 27

The Moon occults Spica on January 23

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.

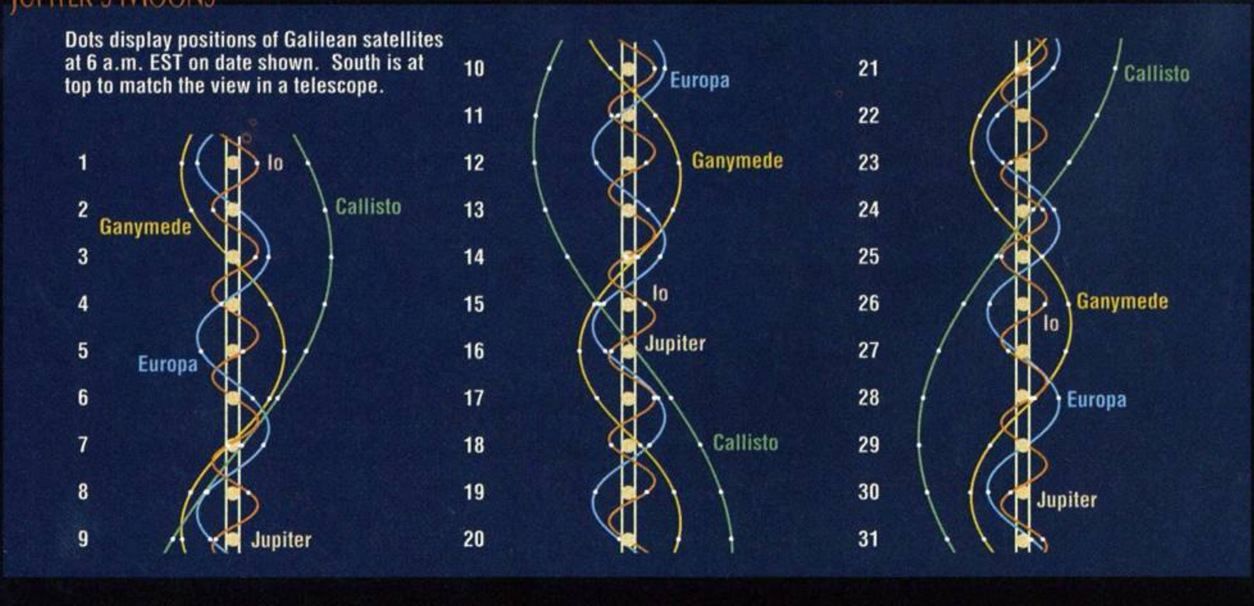

3
2
1
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17

To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved light-blue line.

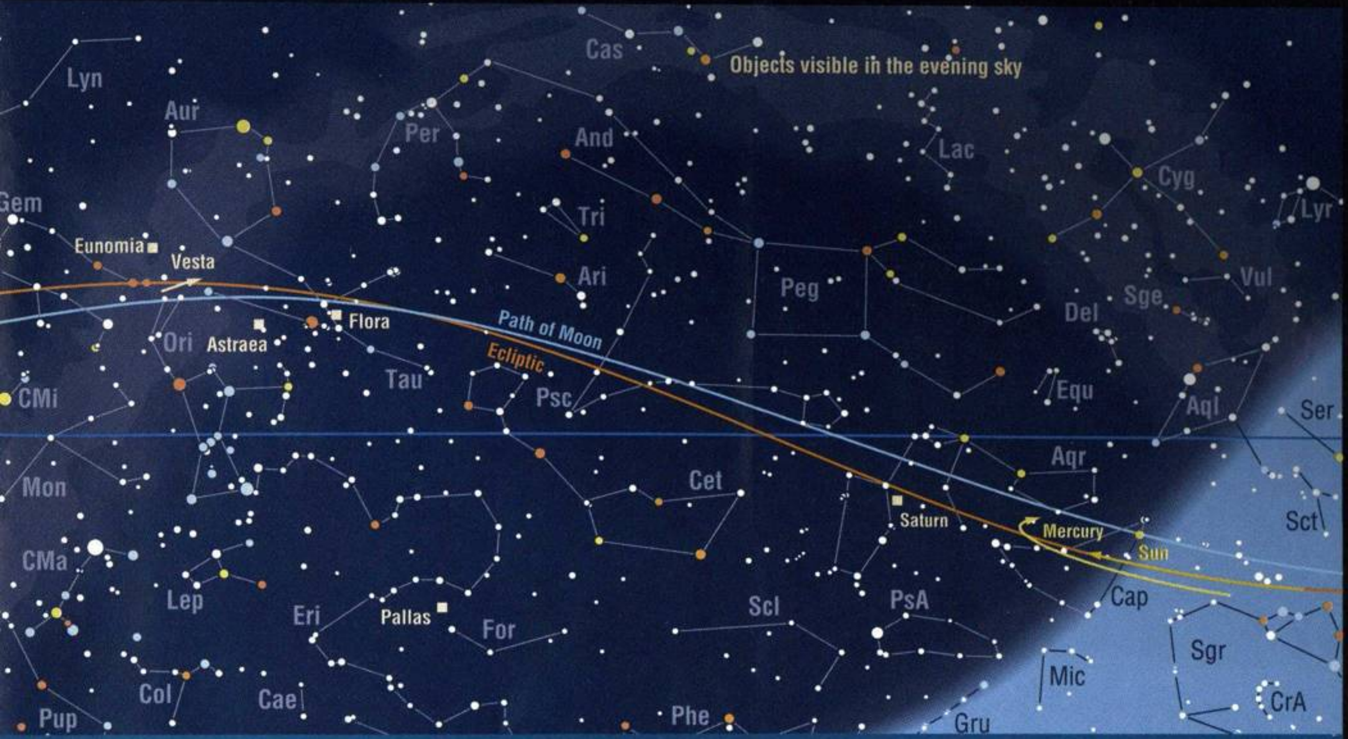


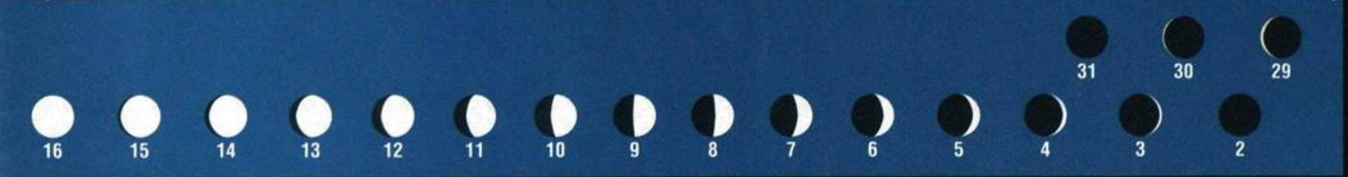
PLANETS	MERCURY	MERCURY	VENUS	VENUS	MARS
Date	January 1	January 15	January 1	January 31	January 15
Magnitude	–0.9	–0.8	–4.5	–4.3	–0.7
Angular Size	5.0"	6.2"	28.8"	20.7"	12.4"
Illumination	95%	72%	43%	59%	97%
Distance (AU) from Earth	1.341	1.087	0.579	0.806	0.757
Distance (AU) from Sun	0.415	0.338	0.718	0.720	1.649
Right Ascension (2000.0)	19h29.8m	21h00.1m	15h29.6m	17h37.0m	10h20.7m
Declination (2000.0)	–24°01'	–18°15'	–15°14'	–20°26'	14°35'

JUPITER'S MOONS



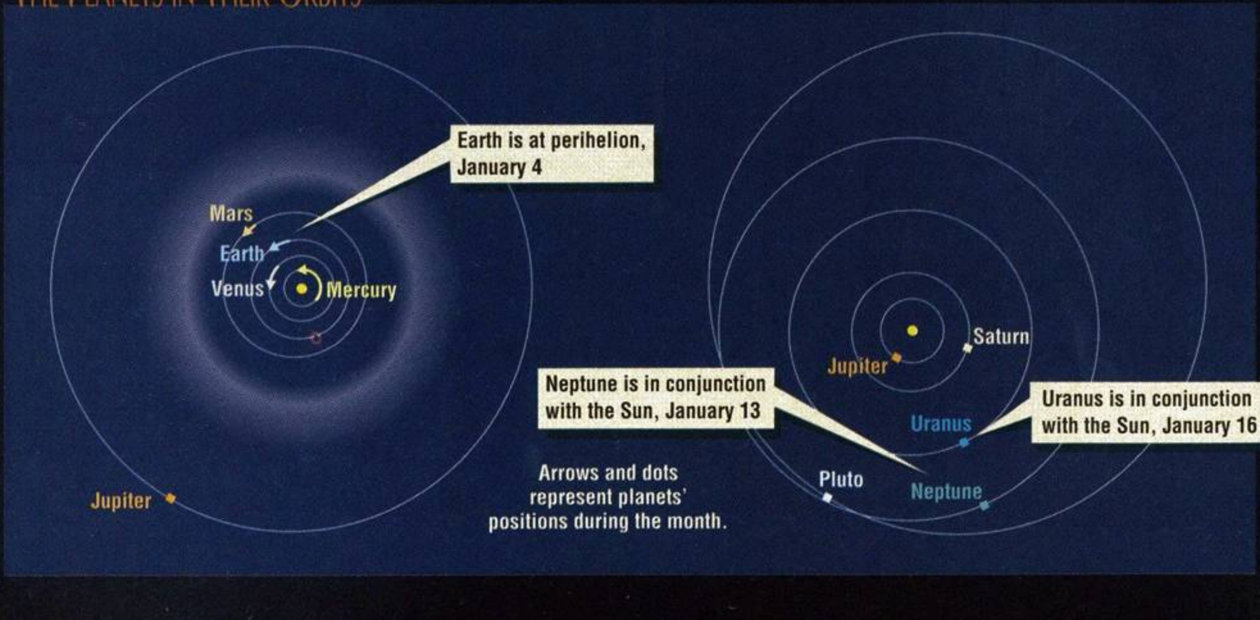
Dots display positions of Galilean satellites at 6 a.m. EST on date shown. South is at top to match the view in a telescope.


Objects visible in the evening sky
Lyn
Aur
Cas
Per
And
Lac
Cyg
Lyr
Gem
Tri
Eunomia
Vesta
Ari
Peg
Vul
Sge
Del
Flora
Ori
Astraea
Path of Moon
Ecliptic
Tau
CMi
Psc
Equ
Aql
Ser
Mon
Cet
Aqr
Saturn
Mercury
Sun
Sct
CMa
Lep
Eri
Pallas
For
Scl
PsA
Cap
Sgr
Mic
CrA
Col
Cae
Pup
Phe
Gru


31
30
29
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2

JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
January 15	January 15	January 15	January 15	January 15
–1.8	1.0	5.9	8.0	13.8
32.9"	16.1"	3.4"	2.2"	0.1"
100%	100%	100%	100%	100%
6.000	10.349	20.676	31.157	30.362
5.377	9.678	19.693	30.173	29.816
16h23.0m	22h46.1m	19h53.5m	19h39.3m	16h02.3m
–20°48'	–9°44'	–21°23'	–20°55'	–7°02'

THE PLANETS IN THEIR ORBITS


Mars
Earth
Venus
Mercury
Jupiter
Saturn
Jupiter
Uranus
Pluto
Neptune

Earth is at perihelion, January 4

Neptune is in conjunction with the Sun, January 13

Uranus is in conjunction with the Sun, January 16

Arrows and dots represent planets' positions during the month.

1995

JANUARY

1 New Moon is at 6:56 a.m. EST
Mercury passes 3° south of Neptune, 9 p.m. EST

2 Asteroid 654 Zelinda is at opposition (p. 62)

3 Quadrantid meteors peak, 6 p.m. EST (p. 59)
Mercury passes 1.7° south of Uranus, 8 p.m. EST

4 Earth is at perihelion (91,403,364 miles from the Sun), 6 a.m. EST

8 First Quarter Moon is at 11:46 a.m. EST

11 The Moon is at apogee (251,781 miles from Earth), 5 p.m. EST

13 Venus reaches greatest western elongation (47°), 7 a.m. EST (p. 61)
Neptune is in conjunction with the Sun, noon EST

14 Venus passes 3° north of Jupiter, 4 a.m. EST

16 Full Moon is at 4:26 p.m. EST
Uranus is in conjunction with the Sun, 7 p.m. EST

19 Mercury reaches greatest eastern elongation (19°), 3 a.m. EST

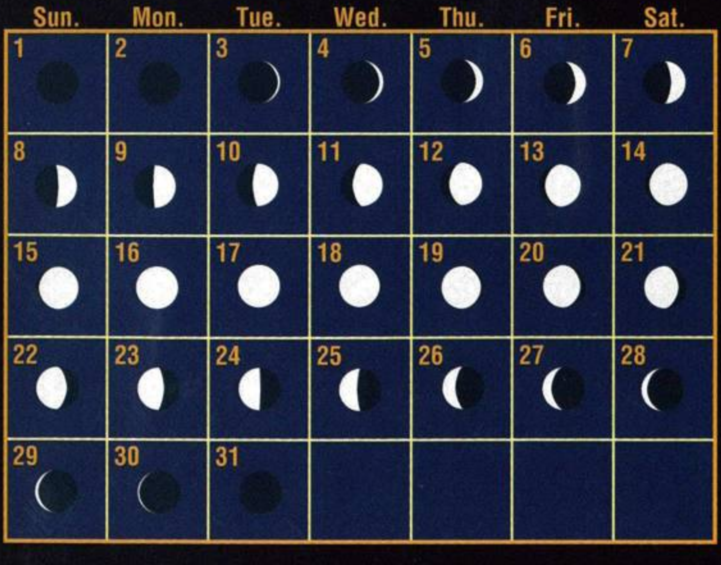
23 The Moon passes 0.6° north of Spica, 6 a.m. EST (p. 59)

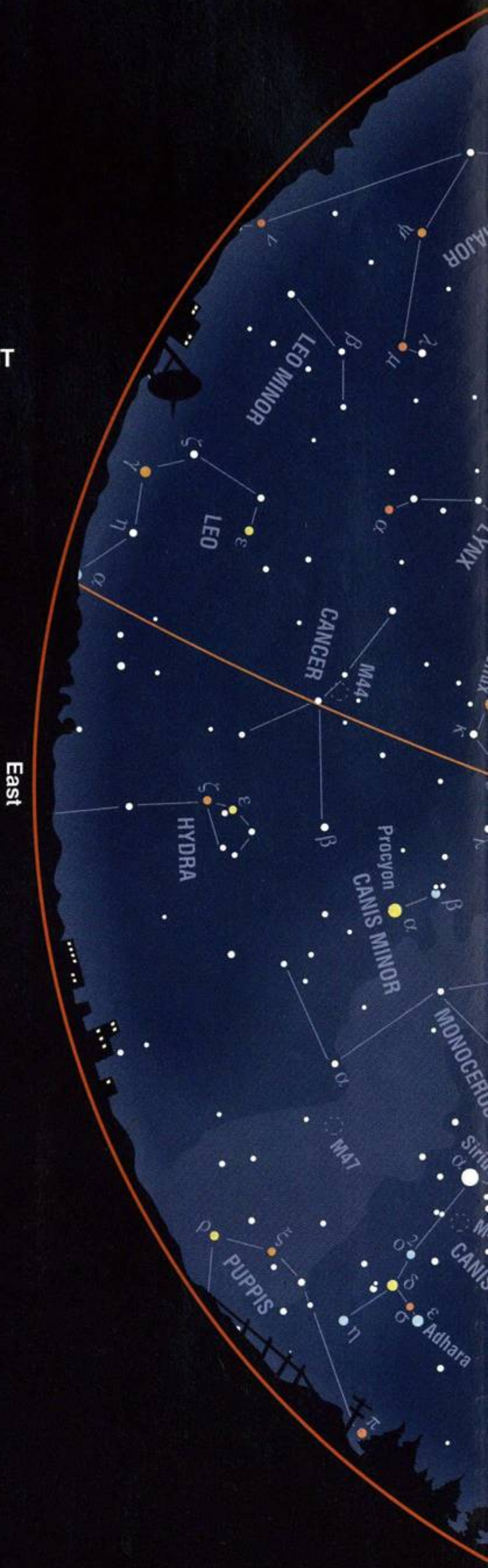
24 Last Quarter Moon is at 12:58 p.m. EST

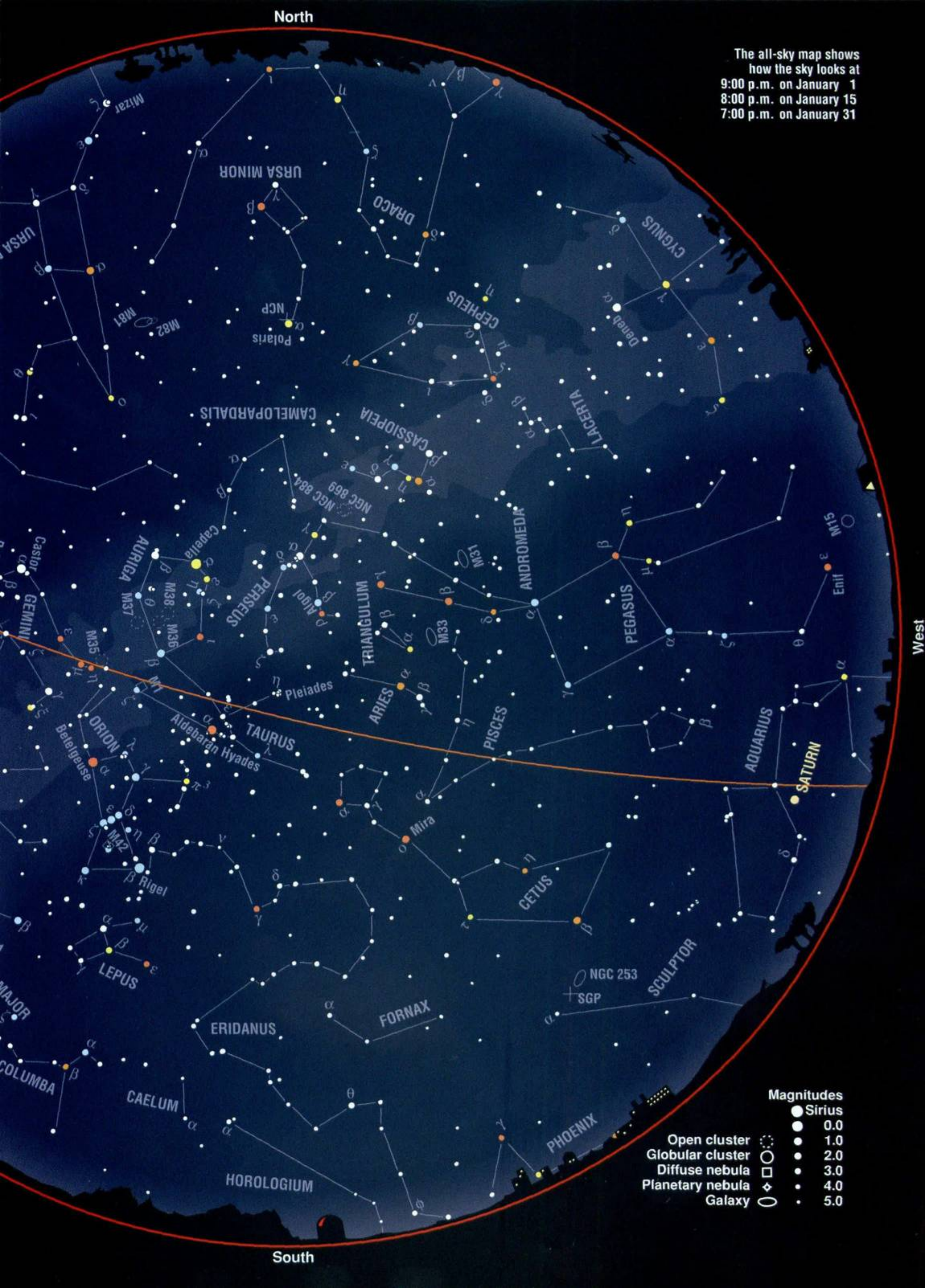
26 The Moon passes 1.7° north of Jupiter, noon EST

27 The Moon passes 0.2° north of Venus, 7 a.m. EST (p. 61)
The Moon is at perigee (227,351 miles from Earth), 6 p.m. EST

30 New Moon is at 6:48 p.m. EST


Sun.
Mon.
Tue.
Wed.
Thu.
Fri.
Sat.
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31


East
LEO MINOR
LEO
CANCER
M44
HYDRA
Procyon
CANIS MINOR
M47
PUPPIS
Adhara


North
South
West
Mizar
URSA MINOR
URSA
DRACO
CYGNUS
Deneb
CEPHEUS
M81
M82
NCP
Polaris
CAMELOPARDALIS
CASSIOPEIA
LACERTA
NGC 884
NGC 869
Capella
AURIGA
PERSEUS
Algol
M31
ANDROMEDA
PEGASUS
M15
Enif
Castor
GEMINI
M37
M38
M36
M35
TRIANGULUM
M33
M1
Pleiades
ARIES
PISCES
AQUARIUS
SATURN
Betelgeuse
ORION
Aldebaran
Hyades
TAURUS
Mira
M42
Rigel
CETUS
LEPUS
NGC 253
SGP
SCULPTOR
MAJOR
ERIDANUS
FORNAX
COLUMBA
CAELUM
PHOENIX
HOROLOGIUM
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0
Open cluster
Globular cluster
Diffuse nebula
Planetary nebula
Galaxy

The all-sky map shows
how the sky looks at
9:00 p.m. on January 1
8:00 p.m. on January 15
7:00 p.m. on January 31

while Jupiter passes 5° north of Antares on January 22.

The scorpion comes out of the dawn with its tail arcing toward the horizon. You probably can't see all of the tail this month, but you can see three little stars in a smaller arc above Antares. These stars are called "the crown of the Scorpion." It is interesting to watch the fixed pattern of the scorpion ascend in the predawn sky, while Venus and Jupiter pursue their individual paths on our sky's dome. Their separate motions stem solely from the fact that they are millions of times closer to us than the stars.

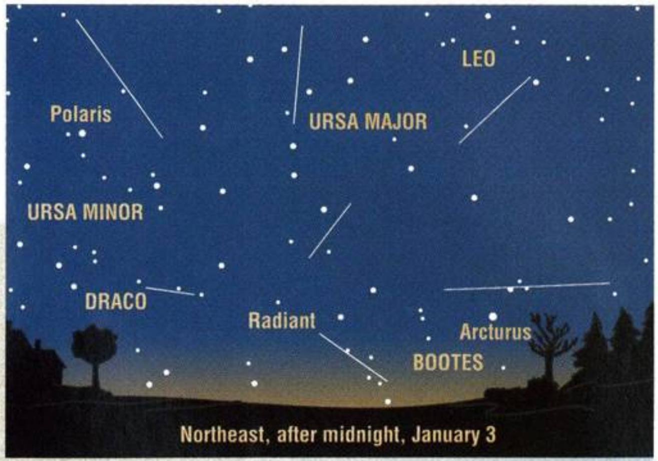
Finally, watch late in the month as the closest planetary body of all, our companion Moon, sweeps past the morning planets. Jupiter lies 1.7° south of the Moon on January 26. Venus is 0.2° south of the Moon on January 27. From Central America on the 27th, the Moon passes in front of the bright planet, blocking it from view.

Meanwhile, in the evening sky, reddish Mars grows brighter and appears for more hours of the night as it gets closer to its February opposition. By mid-January it comes over the eastern horizon about three hours after sunset, nearly at its brightest for the year at magnitude –0.5. Mars will be closest to us on February 11, one day before it is directly opposite the Sun.

Mars now lies in Leo. While it's easy to notice that the planets Venus and Jupiter are moving against the starry backdrop, a similar motion for Mars is not so easy to discern. That is because this month Mars reaches its "stationary" point, where it stops moving in its usual eastward direction and begins to edge west. Between these two motions, Mars hangs motionless in front of the stars. Its stationary point comes on January 3. The westward or "retrograde" motion of Mars baffled the ancients, but it occurs whenever Earth goes between any outer planet and the Sun.

First Views:

Quadrantid Meteors



Northeast, after midnight, January 3

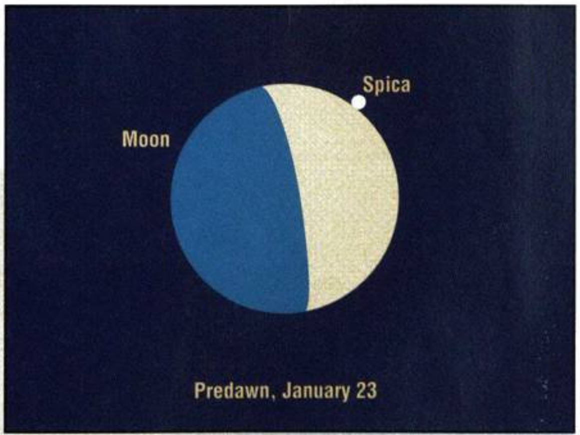
The Moon is a thin waxing crescent on January 3, so the stage is cleared for the Quadrantid meteor shower, which peaks on that day at 6 p.m. EST. The radiant, which lies in northern Bootes, is circumpolar in many locales in the Northern Hemisphere, but it doesn't rise high into the sky for observers in the United States until around 1 a.m. Hence, we will probably not get our best views of this shower until near midnight and into the morning hours of the 4th.

For the Quadrantids, the maximum zenithal hourly rate — the number of meteors an observer can expect to see during the peak in a clear, dark sky when the radiant is overhead — fluctuates between 60 and 110. The Quads are fairly slow moving, and are usually not very bright. Dark sky conditions help, as does having a cloud-free sky, which may be rare in January!

If you want to do your thing for science, how about counting some falling stars? Go out and count the number of Quadrantid meteors you see per hour a few days before and after the peak. Report your observations, along with your location (latitude and longitude), seeing conditions, and observing times, to Rainer Arlt, Visual Commission, International Meteor Organization, Berliner Strasse 41, D-14467, Potsdam, Germany. Such observations help further our understanding of near-Earth meteor activity and our local interplanetary environment, which, in turn, sheds light on cosmic debris in the solar system.

Gert Kroner

The Moon Pairs with Spica



Predawn, January 23

On the morning of the 23rd, the Last Quarter Moon occults Spica, an event that will be visible across most of North America, except Alaska and northern Canada. The occultation begins around 6 a.m. EST and ends about two hours later. Daylight will interfere with the end of the occultation for observers in the central and eastern time zones.

Spica may be the brightest object in Virgo, but next to the half-lit Moon, its visual presence pales. Binoculars or a small telescope help bring out the star, though with Spica passing behind the Moon's bright west limb, you need moderate magnification to really appreciate the drama of the star's disappearance.

Up until the occultation, Spica sits off the bright lunar limb like a diamond chip that has become separated from its grander setting. That view alone will be worth a peek.

The Quadrantid meteors, which always peak in early January, radiate from a region of the heavens that used to be called Quadrans Muralis. The constellation of the "wall quadrant" is now divided between Bootes, Hercules, and Draco. The Quadrantid shower is not easy to observe, however, because it produces meteors for a very short time, a few hours at most. In recent years, some observers in exactly the right place on Earth at the right time have reported rich displays of Quadrantids. This year the Moon is out of the way.

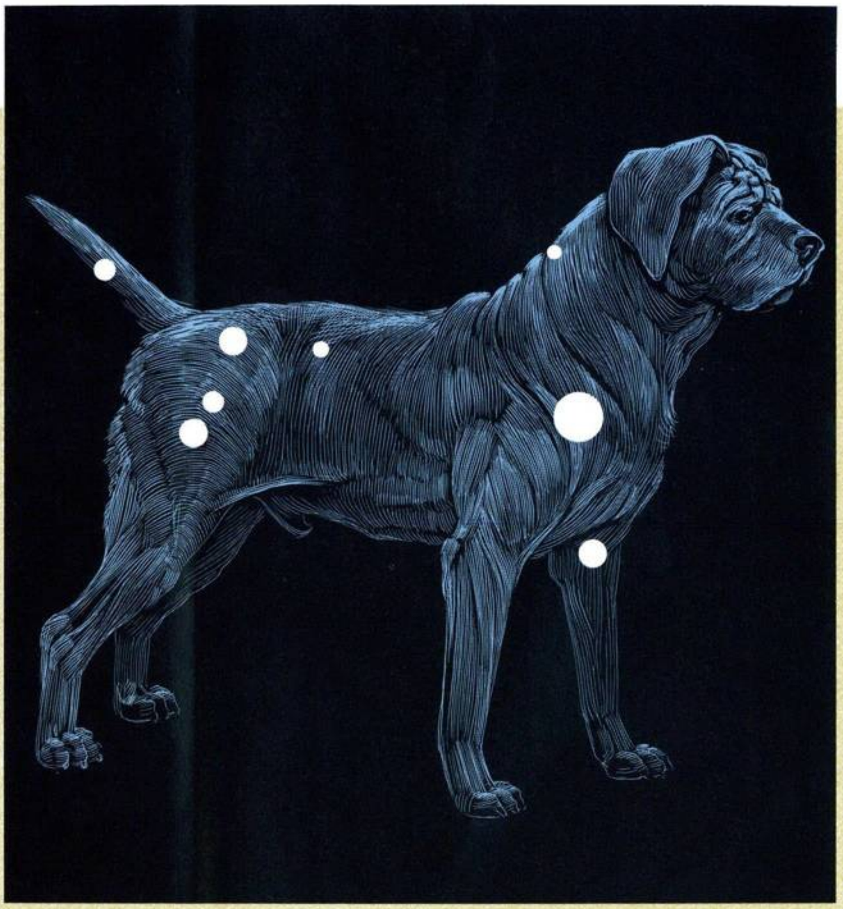
Comet Borrelly's opposition comes on the 20th. Be sure to turn your binoculars in its direction. Another member of our Sun's family comes to opposition on January 2. When you search for the asteroid 654 Zelinda, remember that there will be no telltale cometlike fuzziness to give its identity away. The asteroids — whose name means "starlike" — can be told apart from stars only by their motion against the star background.

January's Planets

Uranus and **Neptune** both lie close to the speedy trek of **Mercury** this month. All three planets are in the western sky after sunset, but when the conjunctions occur all three are too low in the sky to be visible. Mercury is 3° south of Neptune on January 1. It is 1.7° south of Uranus on January 3.

Uranus and Neptune then go on to pass behind the Sun as seen from Earth. Neptune is in conjunction with the Sun on January 13. Uranus is in conjunction with the Sun

The Starry Sky: Canis Major



Henry Nebel

The brightest star of all is Sirius, the Dog Star, in the constellation Canis Major, the Greater Dog. Its brilliance makes it impossible to mistake, but any confusion can be remedied by glancing at Orion's Belt, which points generally toward Sirius.

As seen from the United States, the Dog Star rises in the southeast and arcs across the southern sky. The height of the arc depends on your latitude. We southerners see this star at its highest as a glittering white diamond about halfway to overhead.

The constellation Canis Major, sometimes called the Dog of Orion, makes one of the sky's most interesting patterns. Sirius is central in a straight line of three stars. The 2nd-magnitude star to the west is called Murzim, "The Announcer," because it rises shortly before Sirius. The Dog's hips are marked by a small triangle of 2nd-magnitude stars. They are called Adhara, Aludra, and Wesen.

On a clear night, to the right of a line between Sirius and this triangle, a bright open star cluster, M41, can be seen with the naked eye. No doubt it was the prominence of Sirius that caused this cluster to be known in ancient times. It was mentioned by Aristotle in 325 B.C. as one of the sky's mysterious "cloudy spots."

Five thousand years ago in ancient Egypt, Sirius was worshipped as the Nile Star or Star of Isis. Its appearance in the predawn sky each summer heralded the start of the annual flood of the Nile River, whose fertile sediments made the river valley one of civilization's first cradles of agriculture.

Sirius can be seen rising shortly before the Sun in the hottest part of summer. In the Middle Ages, skywatchers believed that the combined light of the Sun and the Dog Star created the extreme summer heat. Consequently, the hottest weeks of summer are still sometimes known as Dog Days.

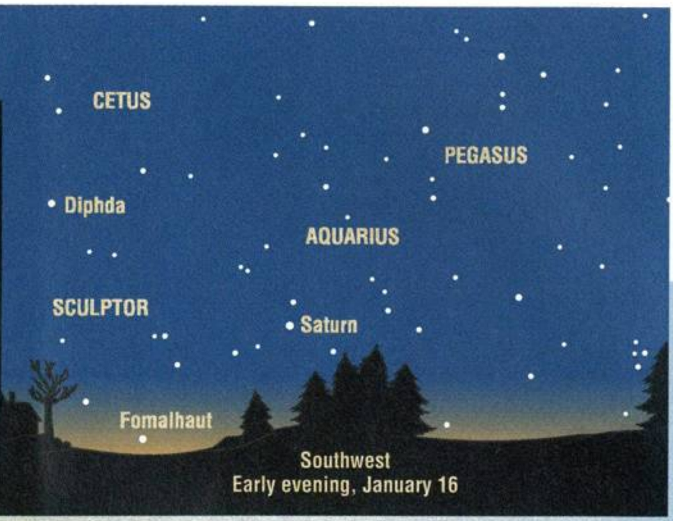
The name Sirius comes from a Greek word meaning "the trembling one" or "sparkling one." Its twinkle is so fierce because it is so bright, and because it is often seen low in the sky, from whence its light must travel to us through a greater-than-usual thickness of atmosphere. Earth's atmosphere also causes Sirius to flash many different colors, yet if you saw this star from outer space it would shine purely white.

In many ways, our earthly perspective on Sirius causes it to be special to us. Sirius may be our sky's brightest star, but it's no giant in the Milky Way Galaxy. It's an ordinary main-sequence star, about twice the diameter of the Sun. It is bright because it is very close, the nearest of all naked-eye stars visible from mid-northern latitudes, at about 8.6 light-years away.

Hidden to the eye, however, is something truly amazing about Sirius. Its companion, Sirius B, sometimes called the Pup, was the first white dwarf discovered and is still the brightest and nearest of all the white dwarfs. It was first sighted in 1862. Sirius B has an average density over 100,000 times greater than that of water. A handful of this star's material weighs as much as an elephant. Such will be the final state of stars like the Sun. — *Deborah Byrd*

Saturn Owns the Evening Sky

U.S. Naval Observatory



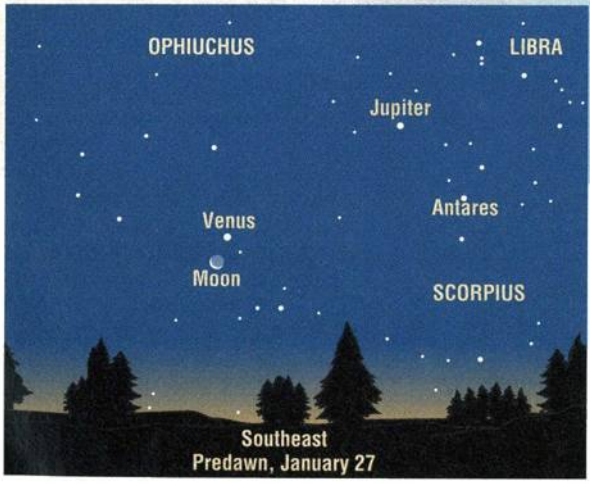
Four months after opposition, Saturn has sort of planed out as far as magnitude and apparent diameter are concerned. Throughout January Saturn holds at magnitude 1, and doesn't vary in diameter by more than 0.7". Still, Saturn is a planet to watch this year because Earth will pass twice through the ring-plane: The first time, May 22, Earth passes from north to south. Then, on August 11, we pass from south to north. During these times, Saturn's rings gradually dwindle to an edge-on presentation, like looking along the cutting edge of a knife. For brief intervals around these times, the rings totally vanish from view in a telescope.

During Saturn's 29.5-year orbit, we see two sides of this ringed wonder. For approximately fifteen years we see the north face inclined in our direction, then, as Earth's orbit gradually slips through Saturn's orbital plane, which is inclined 2.5° to the ecliptic, we see the planet turn its south face our way. Saturn's rings were last edge-on in 1980, and maximally inclined toward the Sun in 1987. We'll see the rings at their maximum inclination again — this time the south face — in 2002.

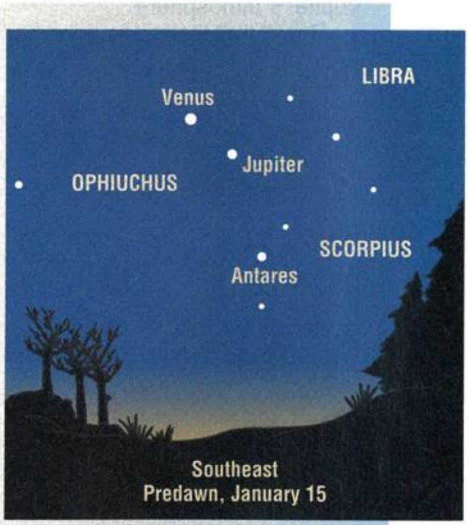
The Moon Passes Venus

On the 27th, the waning crescent Moon, just three days before new, rises in the morning sky with bright Venus just off to the southwest. The minimum angular separation apparent in the United States is about 0.2°. From southern Mexico or Central America, you can see a spectacular occultation. But this pairing will be stunning in its own right, and an opportunity for astrophotographers to snap a memorable celestial-terrestrial composition.

Here's my suggestion: Use a 100 mm telephoto and Kodachrome 64 film — it's forgiving of exposure and has such a fine grain that it doesn't look like a Navajo sand painting when enlarged. Set your lens to f/4 or 4.5 and bracket 1/2-second exposures at least two stops. (Move up a stop and shorten exposure time with faster film.)

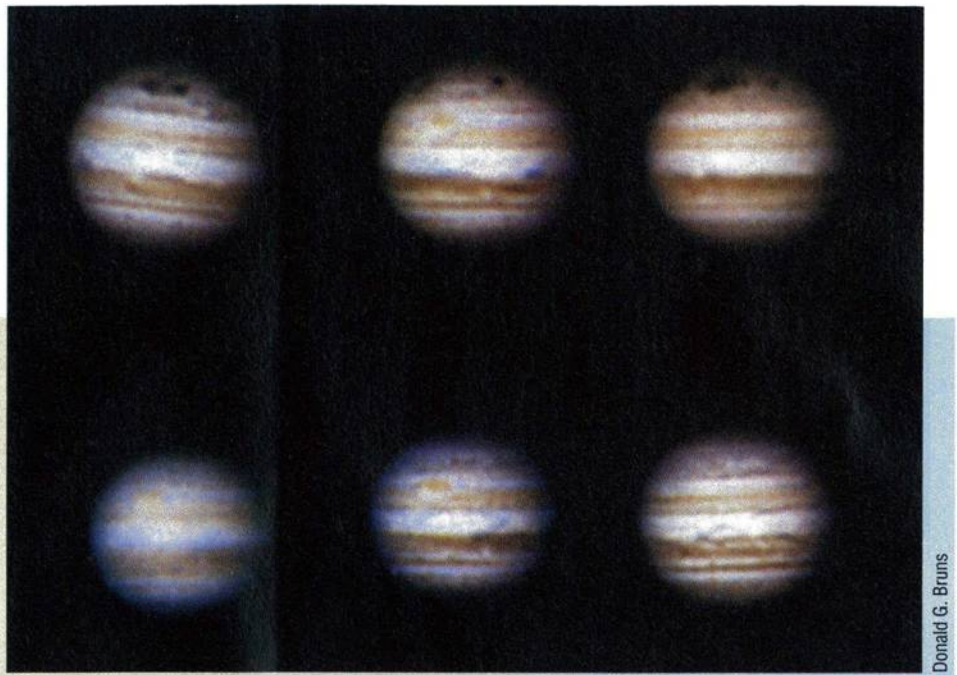


Wake Up with Venus



You morning folk have another reason to greet the day with a whoop. Venus is more prominently placed in the morning sky after lying low along the eastern horizon for the past month and a half. Last year, the planet graced the western evening sky and was no doubt the cause of many a UFO concern. This year, it beams brightly through the cold morning twilight like a distant jet coming in with its landing lights on.

Still fresh from inferior conjunction, the planet sports a kind of half-moon phase that is quite visible in any size telescope. Don't use high power, though, because you'll only magnify the turbulent convective cells in Earth's atmosphere that make stars and planets twinkle violently. You can't see anything on Venus anyway; the planet, like Milwaukee or Seattle, is constantly obscured in clouds, so even the best of telescopes renders a dazzling white ball. The interesting thing to look for and monitor is the phase of the planet as it edges away from the Sun. Over the coming weeks, the planet will grow fuller.



Donald G. Bruns

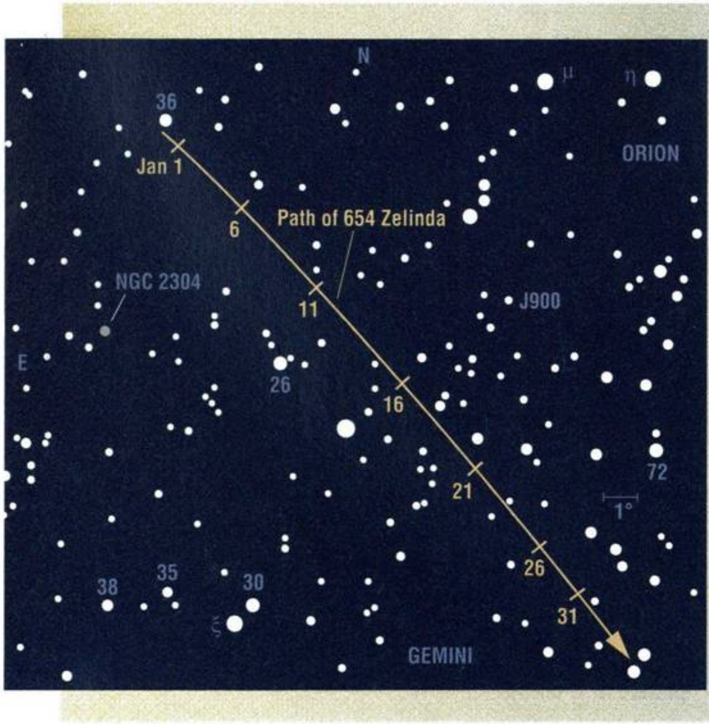
Observer's Challenge: **Jupiter Loses Its Spots**

It's a little difficult at press time to predict the disposition of Jupiter's comet scars by January, especially since this kind of event has never before been observed. When Comet Shoemaker-Levy 9 struck Jupiter in July, it produced a series of black splotches in the planet's southern hemisphere. Some astronomers predict these features may remain visible for a year or more, although they may fade beyond the reach of small telescopes. The bottom line is, nobody knows how these things will behave in the next few months, or how long they will remain visible. The best advice for observing Jupiter is to remain vigilant. If nothing else, as these features fade, they will encourage observers to appreciate the many other subtle details visible in Jupiter's atmosphere.

Recall that the impact sites began to blend with each other before the week of collisions had even concluded, so it's no surprise that they have continued to merge, although most are still identifiable. The largest impact, from fragment G, persists as a subtle knot in the band of comet bruises, but even that feature is probably not long lived.

What would be interesting to do now would be to delve into the records of the Association of Lunar and Planetary Observers or observatory photographic archives looking for features that resemble the ones seen in the immediate aftermath of S-L 9. Perhaps comet collisions around Jupiter happen more often than we think; perhaps someone else will discover the traces of a long gone comet. If so, wouldn't that say something interesting about Jupiter and the not-too-distant interplanetary environment?

Observing Asteroid 654 Zelinda



ASTEROID 654 ZELINDA POSITIONS

Date	R.A.(2000)Dec.	Mag.
Jan. 1	6h49.7m +21°25'	9.6
Jan. 6	6h43.0m +20°03'	9.7
Jan. 11	6h36.6m +18°40'	9.9
Jan. 16	6h30.7m +17°19'	10.1
Jan. 21	6h23.6m +16°02'	10.2
Jan. 26	6h21.3m +14°50'	10.4
Jan. 31	6h15.5m +13°44'	10.5

Diving down through western Gemini and into Orion is the 75-mile-wide carbonaceous body 654 Zelinda. At opposition on January 2, it reaches a bright apparent magnitude of 10, making it detectable in a 4- to 6-inch telescope.

On the first, the Zelinda search region lies about 4° west of Zeta (ζ) Geminorum. As the month progresses, the asteroid moves rapidly southwest (its inclination to the ecliptic is a rather steep 18°). On the 17th, Zelinda lies a little over 1° west of Gamma (γ) Geminorum and by the month's final week crosses into northern Orion (northwest of the Hunter's club). Use the finder chart and table of coordinates to locate this minor planet.

on January 17. They'll both return to the predawn sky in February.

Mercury ascends higher in the evening twilight sky to reach greatest elongation — its farthest point from the Sun in the sky — on January 19. Then the innermost planet is 19° east of the Sun and visible as a surprisingly bright object low in the west-southwest 45 minutes after sunset.

Saturn, in Aquarius, is also in the west after sunset. This planet sets about three hours after sunset in early January, but by the end of the month it follows the Sun below the horizon by only about an hour. Saturn has now dimmed to magnitude 1.0 because it's nearly behind the Sun as seen from Earth. It'll pass behind the Sun in early March.

The time for viewing Saturn through a telescope ends this month, so take one last peek. The planet is already so low in the sky that you're seeing it through a greater-than-usual thickness of atmosphere. The planet's rings now appear nearly edgewise from our earthly vantage point. In May, they'll be precisely edge-on to Earth, at which time the broad and glorious rings of Saturn will seem to disappear.

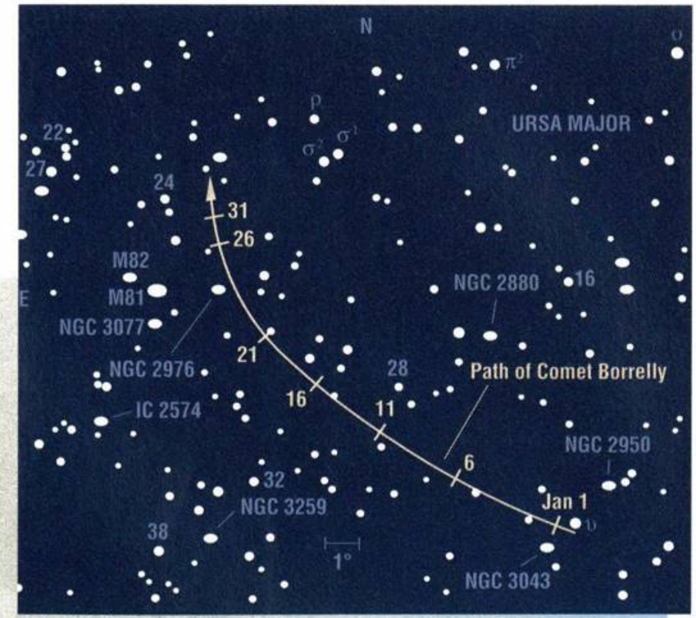
Mars comes up in mid-evening when the month begins and by the end of the month can be found soon after true darkness falls. This planet is now moving toward its February opposition, when Earth will pass between Mars and the Sun. Mars can be very inconspicuous when it is on the far side of the Sun from us, but it's shining brightly now at magnitude –0.5.

Pluto is up several hours before the Sun now. It is about a thousand times too faint to see with the eye alone.

Venus reaches greatest elongation on January 13. It is 47° west of the Sun, a brilliant object in the east before dawn. Jupiter is below Venus when the month begins and above it in the predawn sky by the month's end. □

Comet Borrelly Reaches Opposition

Cutting through northwestern Ursa Major, and an easy target in binoculars in a dark, haze-free sky, is Comet Borrelly. This periodic comet, discovered in 1902, comes around every seven years. Its 1987 return was a little better than this year's, but this apparition is not bad either. When it reached perihelion this past November, it peaked about magnitude 7.7. Still, it is holding its own at magnitude 9 as it makes its way toward opposition on January 20. During the last two weeks of January the comet passes close to the bright galaxies M81 and M82, creating a "photo op."



COORDINATES FOR COMET BORRELLY

Date	R.A.(2000)Dec.	Mag.
Jan. 1	9h49.5m +59°14'	8.9
Jan. 6	9h52.2m +61°49'	9.1
Jan. 11	9h52.7m +64°00'	9.3
Jan. 16	9h50.9m +65°48'	9.4
Jan. 21	9h47.1m +67°11'	9.6
Jan. 26	9h41.6m +68°11'	9.8
Jan. 31	9h35.1m +68°48'	10.0

Abdul Hadi Marafie

LIBRARY OF ASTRONOMY

Deep-Sky Observer's Bookshelf

Observing Handbook and Catalogue of Deep-Sky Objects
Contains magnitudes, sizes, positions, surface brightness, and telescopic descriptions for more than 2,000 objects, plus sketches of deep-sky objects made with large telescopes. By Christian B. Luginbuhl & Brian A. Skiff. 8¼ x 12; 352 pgs.; 138 illus.; hrdbd.
#30246 .... **$49.95**

Stars and Galaxies: Astronomy's Guide to Exploring the Cosmos
Thirty-six deep-sky articles from ASTRONOMY magazine explain general deep-sky observing, galaxies, stars, clusters, and bright and dark nebulae. Edited by David J. Eicher. 8½ x 11; 200 pgs.; 129 b&w and 110 color photos; 98 illus.; 34 charts; hrdbd.
#18536 .... **$29.95**

The Universe from Your Backyard
Tour 46 constellations featuring 690 of the finest deep-sky objects. Includes charts, telescopic sketches, and three-color sky maps. By David J. Eicher. 8½ x 11; 188 pgs.; 50 b&w and 90 color photos; hrdbd.
#18037 .... **$29.95**

Fun with Stars and Planets

Binocular Astronomy
See more of the universe than you thought possible with an inexpensive pair of binoculars. Explore star clusters, nebulae, and galaxies. Includes ten-map Bright Star Atlas 2000.0. By Craig Crossen and Wil Tirion. 8½ x 11; 224 pgs.; 24 color photos; 37 tables; hrdbd.
#30262 .... **$24.95**

Star Names: Their Lore and Meaning
The classic book on star lore, which explains the origins of star names in Chinese, Arabic, Hellenic, and Greco-Roman cultures. By Richard Hinkley Allen. 5½ x 8½; 563 pgs.; sftbd.
#30003 .... **$9.95**

The Sky: A User's Guide
Learn how to identify the constellations, spot planets, seek out galaxies, and choose or make your own telescope with this comprehensive beginner's guide to astronomy. You'll find many practical observing tips and historical information, too. By David H. Levy. 7 x 10; 295 pgs.; hrdbd.
#30260 .... **$29.95**

To Know the Stars
A guide to astronomy for children, teachers, and beginners. Takes readers under the stars to learn constellations by sharing the lore of the past. Explains meteor showers, Earth's orbit, and the makeup of the solar system. By Guy Ottewell. 8½ x 11; 41 pgs.; 49 illus.; sftbd.
#30233 .... **$7.00**

A Walk through the Universe

Color Tour of the Milky Way
Sixty-one full-color slides taken by well-known astrophotographer Ronald Royer illustrate the greatest of the Milky Way's many deep-sky objects. Orion Nebula, Eta Carinae, Crux region, central Cygnus, Cassiopeia, Sagittarius, and more. By Ronald Royer. 9 x 11½; 10 pgs.; 60 slides; sftbd.
#30105 .... **$41.95**

The New Cosmos: The Astronomy of Our Galaxy and Beyond
A cutting-edge glimpse of our changing view of the universe. Black holes, radio galaxies, quasars, the Milky Way, high-tech telescopes—explore these and other topics through spectacular color photographs, compelling text, and award-winning illustrations. From ASTRONOMY magazine. 8¼ x 10¾; 160 pgs.; 132 color and 6 b&w illus.; sftbd.
#18537 .... **$19.95**

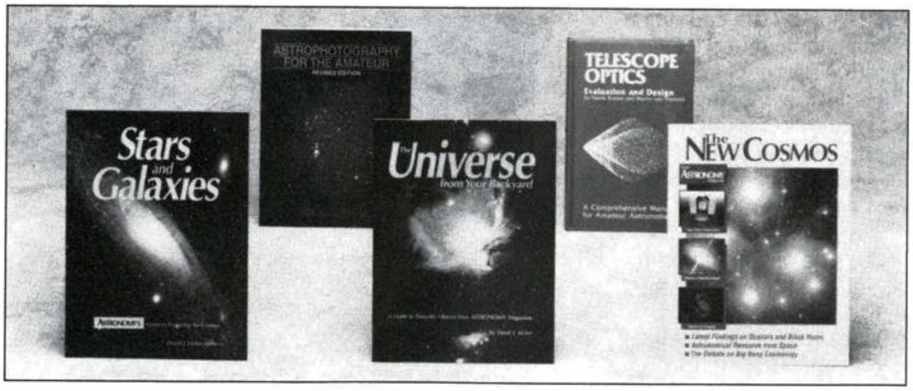
Astrophotography for the Amateur
Capture the beauty of the universe on film. Covers the fundamentals, including information on choosing and developing films and using the correct exposures for the Sun, Moon, planets, stars, and deep-sky objects. By Michael Covington. 7¾ x 9½; 168 pgs.; 96 b&w photos; 34 color photos; 47 illus.; sftbd.
#30256 .... **$17.95**

Lenses and Mirrors

Advanced Telescope Making Techniques Volume 1: Optics
The best material from 21 years of the *Maksutov Circulars*, the influential newsletter for precision amateur telescope makers. By Allan Mackintosh. 6 x 9; 320 pgs.; 42 b&w photos; 450 illus. (Vol. 1&2); sftbd.
#30142 .... **$24.95**

Advanced Telescope Making Techniques Volume 2: Mechanical
#30143 .... **$24.95**

Telescope Optics: Evaluation and Design
A guide to buying or producing your own telescope optics, providing background on lenses and mirrors, telescopic aberrations, and types of optical systems. By H. Rutten & M. Van Venrooij. 6¼ x 9¼; 384 pgs.; hrdbd.
#30175 .... **$24.95**



Astroimaging

Astrophotography
Introduces the techniques of astrophotography to beginners and provides a system for calculating the correct exposures for photographing the Moon, Sun, planets, and stars. By Barry Gordon. 6 x 9; 208 pgs.; 55 b&w photos; sftbd.
#30125 .... **19.95**

To order, call toll free
1-800-533-6644, 24 hours a day.
For faster service call Monday - Friday
8:30 am - 5:00 pm CT.
Please have your credit card ready. Fax 414-796-0126.
Outside the U.S. and Canada call 414-796-8776.

Or use the enclosed order form and mail to: Kalmbach Publishing Co., Dept. AC015, 21027 Crossroads Circle, P.O. Box 986, Waukesha, WI 53187-0986. Include for postage and handling: U.S. add $3.00 for 4th class (or $4.50 UPS in the continental U.S. only) Canada add $5.00, other foreign add $10.00. Maryland and Wisconsin residents add 5% sales tax to total. Virginia residents add 4.5% sales tax to total. Canadian residents add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

Dept. AC015

Zero Image Shift!

> "To put it bluntly, if there's a better line of commercial focusers made for imaging, I don't know about it."
>
> Dennis di Cicco – March, 1994 *Sky & Telescope*

NGF-1

AS LOW AS $88

SOLID ALUMINUM NO PLASTIC

LOWEST PROFILE

Now the Best Focuser Just Got Better

- New One-Piece Construction
- Stronger – Over 8 Pounds of Lift
- New Improved Finish (except NGF4)
- All Models Compatible with Motofocus and JMI DRO (digital focusing)

Don't Get Stuck with Cheap Plastic Imitations or Focusers that Cannot Be Upgraded with Motofocus or DRO's.

JMI HOT PRODUCTS SHOWCASE !!!

Jim's Mobile Inc. • 810 Quail St. Unit E • Lakewood, CO 80215 • Orders: 800-247-0304 • Info: 303-233-5353 • FAX: 303-233-5359

PHONE/MAIL ORDER: VISA, MasterCard, personal check, or money order. **USA & CANADA**: Add shipping charge shown in (parentheses) after price. **OVERSEAS ORDERS WELCOME**: Send VISA or MasterCard number with expiration date, or bank check in US $; add 7% of price for customs preparation and air mail shipping ($15 minimum). Prices subject to change.

*SS = Stainless Steel, CB = Composite/Brass, AA = Anodized AL.

NGF-2 **NGF-3** **NGF-4** **MINI 1** **MINI 2** **MINI 3** **MINI 4**

Shown with optional Motofocus
Shown with optional Motofocus
MOTOFOCUS
MOTOFOCUS

Motofocus upgrade **$90**

NGF-1 Top-of-the-line, designed to make your telescope a showpiece. Polished aluminum body with black drawtube standard (black body upon request). Includes 1.25" adapter. Lifts up to 8 pound load. 6 SS bearings,* **manual** **$229**($3)

NGF-2 Superior for manual focusing. Includes 1.25" adapter. Black only. Lifts up to 8 pound load. 4 SS/2 AA bearings,* **manual** **$179**($3)

NGF-3 Advanced focusing system. Includes 1.25" adapter. Black only. Lifts up to 2.5 pound load. 4 CB/2 AA bearings,* **manual** **$149**($3)

NGF-4 Advanced focusing system for the budget-minded. Single focusing knob. Non-coated aluminum body. 1.25" adapter optional. Lifts up to 2.5 lb. load. 4 CB/2 AA bearings,* **manual** **$119**($3)

2"-1.25" adapter **$19.95**

Each model of our popular NGF focusers is now available in 1.25"! (Refer to columns at left for model details. References to 1.25" adapter apply to 2" models only. $3 S&H)

NGF-mini 1	**$169**($3)	**NGF-mini 4**	**$ 88**($3)
NGF-mini 2	**$129**($3)	With **Motofocus**	
NGF-mini 3	**$ 99**($3)	add	**$ 90**($3)
		DRO (digital focusing)	**$229**($3)
		DRO with Motofocus	**$319**($5)

CHRISTMAS SPECIAL FREE 2nd DAY UPS AIR SHIPMENT US & CANADA.
And FREE "INSTRUCTIONAL" VIDEO WITH EACH COMPUTER ORDER.

EXPIRES DECEMBER 31, 1994 – SHIPPING SPECIAL DOES NOT INCLUDE WHEELEY BARS OR NTT TELESCOPES

NEW! ONLY JMI COMPUTERS FIT ALL MEADE STARFINDER and ORION DOBS

EASY, FAST, HIGH QUALITY INSTALLATION

NEW!
MEADE
STARFINDER
MEADE

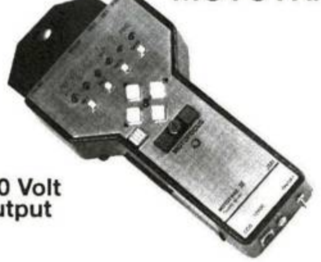
NGC-microMAX, 245 objects! **$449**($5)

NGC-miniMAX, Planets, polar align help. 3800+ objects! **$569**($5)

NGC-MAX, Planets, polar align help, RS-232, 12,100 objects **$769**($5)

Our popular "MAX" computer units are ready to use with your choice of over 70 models of commercial telescopes. They feature high resolution (0.09°) optical encoders and do not require polar alignment or leveling! Easily find any object in the computer's database, even add your own! Ask for our free encoder installation instructions detailing how our encoders mount to your own telescope.

MOTOTRAK V



110 Volt Output

Triple-control drive corrector (dual-axis plus focus) with Lunar, Solar, Sidereal, King and user-definable tracking rates; PEC; CCD auto-guider jack; blinking reticle output; mounting bracket; wall transformer; and cigarette lighter plug. **$349** ($10)

Order with MOTOFOCUS or MOTODEC **$ 70** each

Internal rechargeable battery **$ 50** each

NGF-S with CCD camera
NGF-S for SCT's

This special version of our NGF focuser fits directly onto 2" thread of Meade and Celestron 8"-14" Schmidt-Cassegrain telescopes.

NGF-S With built-in MOTOFOCUS **$289**($3) Includes 2"-1.25" and 2" threaded output adapters. Optional **Large Format Adapter** for 10"+ SCT's **$45**

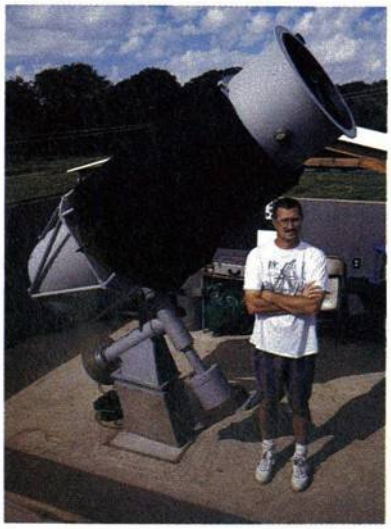
NGF-MiniS 1.25" version not shown (2" travel for SCT's) **$219**($3)

NEW LEVELING WHEELEY BARS FOR MEADE LARGE FIELD TRIPOD
12" & APO – $199.95 ($20 US & CANADA ONLY)

BIG SCOPE OBSERVING

Wrestling a 25-inch scope to an observing site may seem a burden, but the reward is the riches of the deep-sky.

by David Higgins



David Higgins

Ever wonder what it's like to own and use a large telescope? Come along with me as I set up my homebuilt 25-inch f/5 reflector on the dark-sky site of the Texas Star Party. We'll survey some wintertime nebulae and galaxies and get acquainted with the views through a 25-inch scope. (Bring your long-johns, because even West Texas chills the spine early in the morning in January!) But before packing up, let me tell you a little about the instrument we'll turn skyward tonight.

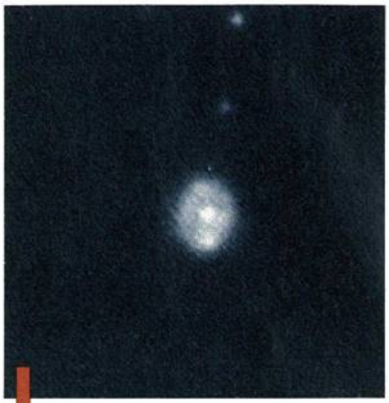
For me, the easiest route to a great quality scope was to buy the optics and, with the assistance of a friend, build an open-tube scope with nicely finished wooden boxes for the primary and secondary/eyepiece holder sections that attach with long aluminum tubes. A black skirt fastens around the tubes, preventing stray light from entering the optical path during observing. The tube design allows me to carefully pack the optics in the two boxes in the cab of my pickup truck, while the rest of the scope and its accessories ride safely in the truck's cargo bed. I've recently placed the scope in an observatory near Oklahoma City so my observing buddies can enjoy it frequently, but several times a year I still make the journey to the dark skies of Fort Davis, Texas, to share the views with friends in the area and to enjoy the ambiance of the Prude Ranch.

The Rosette Nebula

Photo by Jason Ware
(6-inch apochromatic refractor, composite of two 60-minute exposures)

The Cone Nebula

Photo by George Greaney
(6-inch f/7.1 apochromatic refractor, hypersensitized Fuji Super HG 400 film, composite of two 50-minute exposures)



Planetary Nebula NGC 2022

Photo by Martin C. Germano (8-inch SCT at f/10, hypersensitized Tech Pan film, 20-minute exposure)

Whatzzat? Well, would you look at that. We've pulled into the ranch just in time to set up before the prime observing hours roll by. Let's pull the truck over into the lower observing field and assemble the scope. If you can unfold the star maps (I normally use the *Sky Atlas 2000.0* and *Uranometria 2000.0*, by the way), we'll be ready to plop in a low-power eyepiece and take a few stabs at some objects as our eyes begin to dark-adapt. The sky that hangs over us is that of the middle winter. It's 10 p.m., so we see Andromeda, Triangulum, and Fornax sinking in the west, Taurus and Orion practically overhead, and the springtime constellations Cancer, Hydra, and Leo rising over the mountains in the east.

Because this is your first time out with the scope, I've taken the liberty of drawing up an observing list of targets to view. Now that you've adjusted to the dark, let's catch the Fornax Dwarf Galaxy, a faint object that you couldn't easily see in a smaller scope. Then we'll engage the rich Milky Way of Monoceros and Orion by looking at the Rosette Nebula, the Cone Nebula, the Orion Nebula, M78, and NGC 2022. By early morning we'll have seen an awful lot and can finish off with something different, perhaps the globular cluster NGC 2419 in Lynx and the

The Horsehead Nebula

Photo by Gerald Rhemann (6.7-inch f/1.5 Schmidt camera, Fuji Super HG 400 film)

Emission Nebula NGC 2024

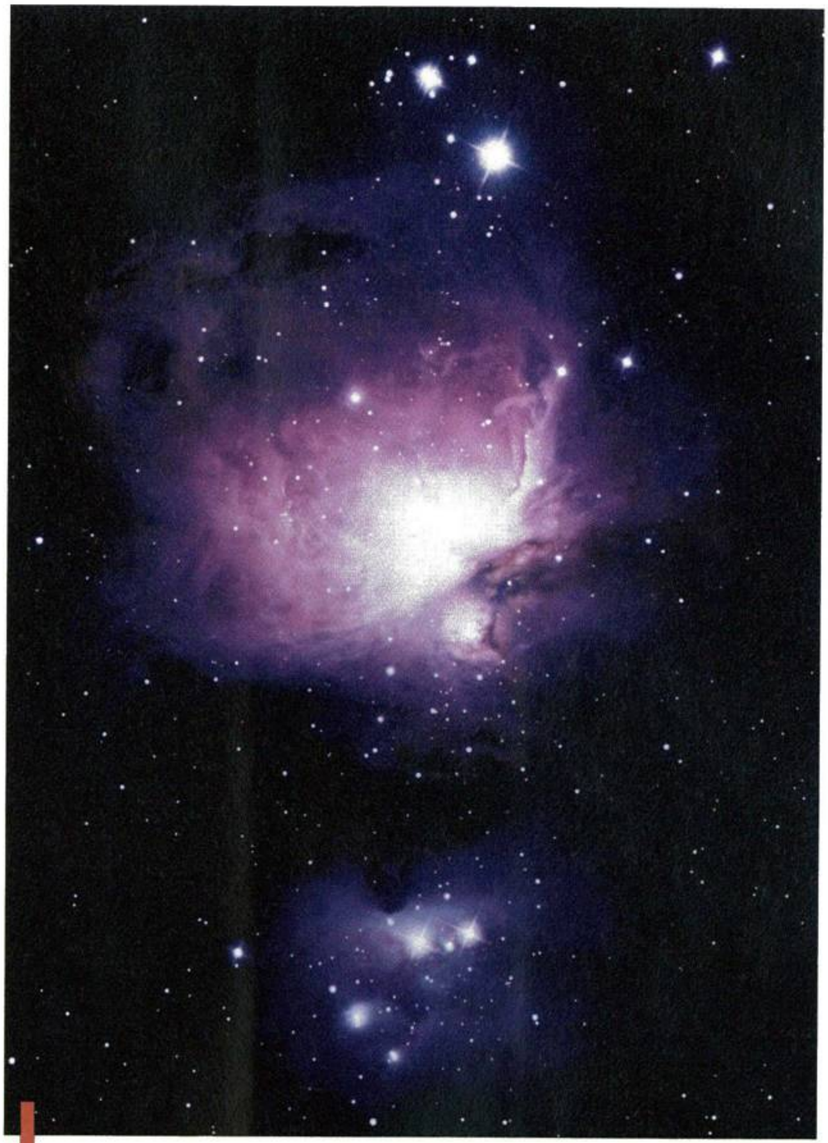
Photo by Jack Marling (17.5-inch f/4.5 reflector, Fujichrome 400 film, 40-minute exposure taken with a Deep-Sky filter)

galaxy NGC 2903 in Leo.

The **Fornax Dwarf** appears as a faint glow in the center of my lowest power field. It's a little cloud of stars in our Local Group of galaxies that was discovered only in 1938, so it's relatively amazing that backyard scopes, even big ones, show it. The object resembles a giant, unresolved globular cluster with only a few dozen dim stars scattered over an extremely faint, diffuse circle of light. By tapping the scope's tube gently, you'll see at least a faint glow in the correct position for this galaxy.

The five globular star clusters orbiting this object are easier to spot than the galaxy itself, and that's particularly true for **NGC 1049**, a magnitude 12.6 fuzzy "star" spanning just 20". The other clusters, one to three magnitudes fainter, lie scattered in the same low-power field. They are **ESO 356-08**, **ESO 356-05**, **ESO 356-01**, and **Hodge 1**. All appear as tiny, fuzzy glows not much larger than the foreground stars surrounding them.

Stepping up to the Milky Way is easy by simply moving the scope and aiming its Telrad finder at the bright star cluster NGC 2244 in Monoceros. Peeking into the low-power eyepiece and carefully focusing will reveal the eerie greenish glow of the **Rosette Nebula**, a wreath-shaped gas cloud that is coalescing into the stars in the cluster inside it. Relatively easy to photograph (with its brilliant red color), the Rosette is difficult to see through a telescope. The culprit is low surface brightness, which makes little parts of the nebula appear dim. Feel free to move the scope around slowly to explore various parts of the

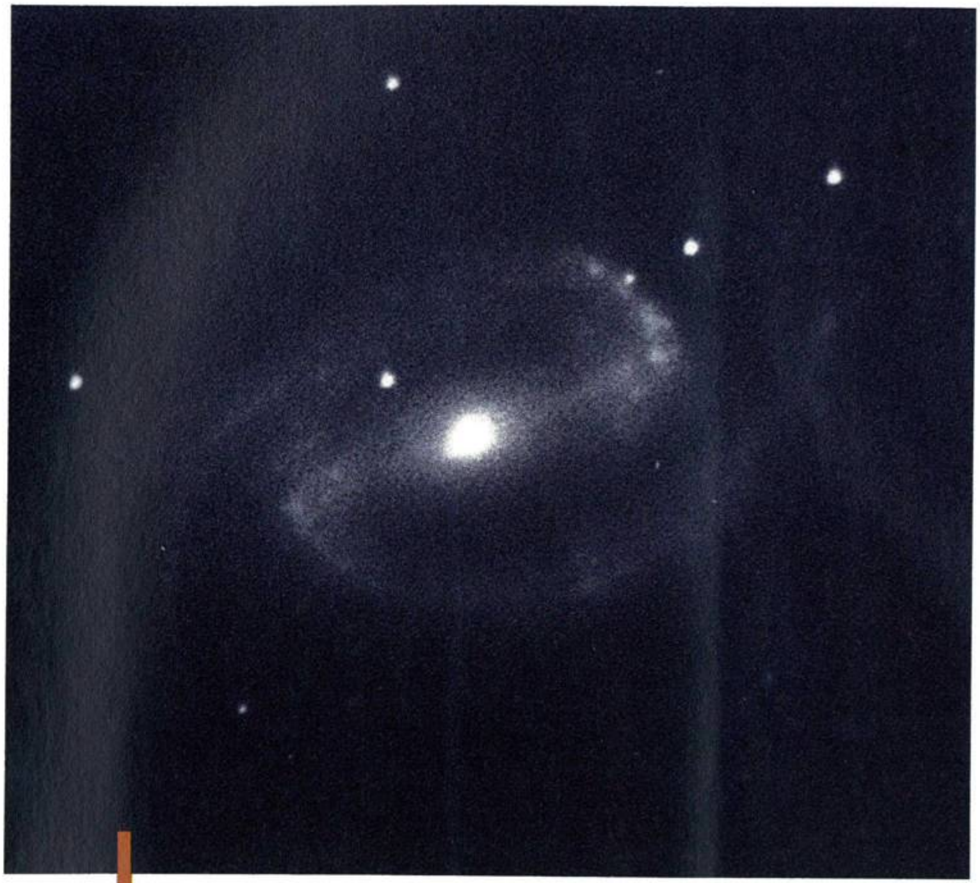


The Orion Nebula

Photo by Bill and Sally Fletcher (8-inch f/4.5 reflector, hypersensitized Tech Pan film, tricolor exposure using 60-minute red, 15-minute green, and 115-minute blue exposures)

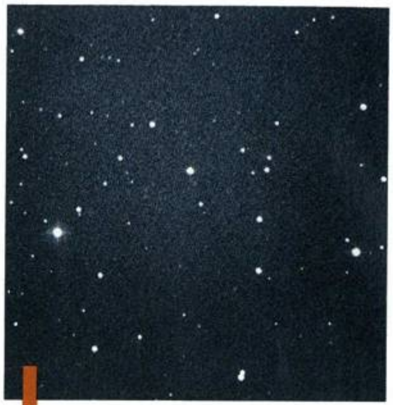
Reflection Nebula M78

Photo by Luke Dodd (4.7-inch f/8.5 apochromatic refractor, hypersensitized Fuji Super HG 400 film, 60-minute exposure)



Barred Spiral Galaxy NGC 1300

Photo by James R. Foster (11-inch SCT at f/11, hypersensitized Tech Pan film, 210-minute exposure)

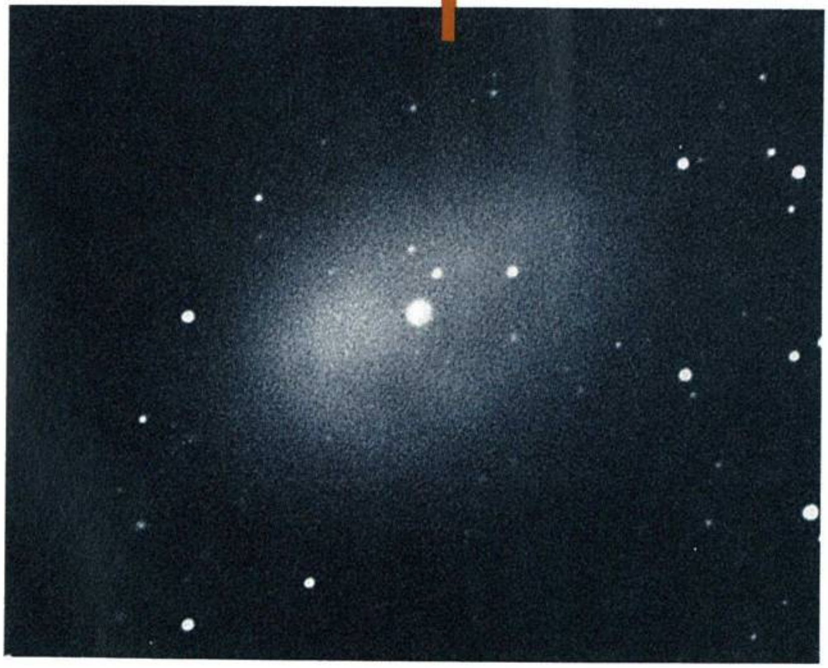


The Fornax Dwarf Galaxy

Photo by Martin C. Germano (8-inch f/5 reflector, hypersensitized Tech Pan film, 75-minute exposure)

Planetary Nebula NGC 1360

Photo by Martin C. Germano (14.5-inch f/5 reflector, hypersensitized Tech Pan film, 70-minute exposure)



Rosette. Its huge size of 80' by 60' means that only a portion of the glow fits in a single eyepiece field. A UHC nebula filter rests in the eyepiece, by the way, which permits seeing impressive detail in the nebula by cutting out skyglow while letting the light from the nebula pass through unimpeded. The northern edge appears sharply defined and several fields of overlapping bright and dark nebulae pop out on nights of good transparency, like this one. The nearby **Cone Nebula**, 5° north-northeast, is somewhat more challenging. It's a dark nebula in the shape of a cone whose outline appears courtesy of bright nebulae that surround it. A moderately high-power view (150x) with the nebula filter reveals the wedge-shaped dark area that appears conelike in photographs.

The **Horsehead** in Orion? Oh, you know that one. Well, okay, but don't expect it to appear as it does in the color photos. We'll divert to it for a brief look. Like the Cone, the Horsehead is a dark nebula visible because bright nebulae surround it, in this case the emission nebula IC 434, a north-south ribbon of weakly glowing light. The Horsehead itself is rather small, measuring only 2' long, and pops out as a notch with an H-B filter, which helps to isolate dim emission nebulae, and relatively high power such as 200x. The head appears rounded on its southwestern side and slopes toward the horse's nose. The horse's neck widens as it blends into the dark cloud that extends eastward from the nebula. Several faint field stars lie just north of the nose.

While we're looking at nebulae in

Spiral Galaxy NGC 2903

Photo by Jack Newton (20-inch f/5 reflector, 20-minute exposure)

Globular Cluster NGC 2419

Photo by Preston Scott Justis (10-inch f/6 reflector, hypersensitized Tech Pan film, 90-minute exposure)

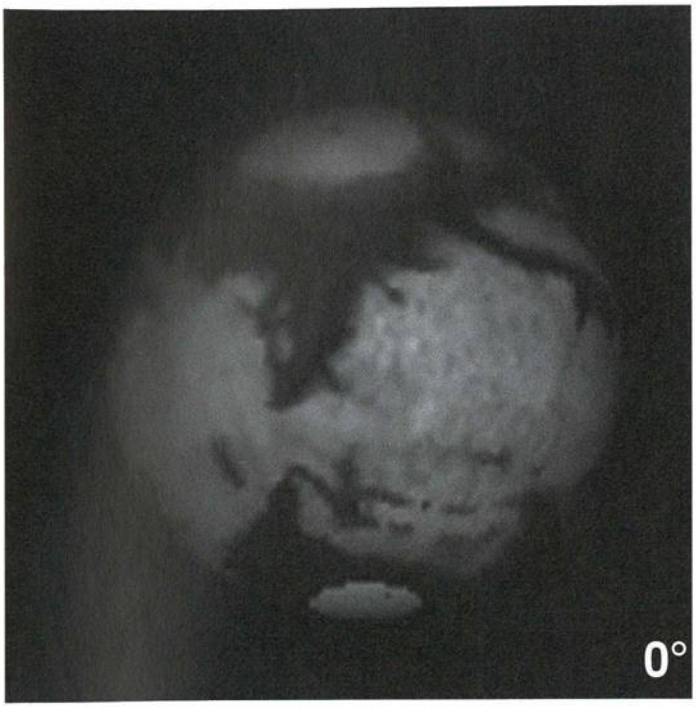
Orion, we can't pass the **Orion Nebula**, the brightest glowing gas cloud in the northern sky. The detail visible in the nebula as viewed with a large scope is breathtaking. Indeed, the object appears almost photographic without the vivid colors usually present in the photos of M42 in these pages. The two-pronged plan works best with M42: sweeping at low power to soak up the full extent of the nebulosity, and examining smaller sections of the object at moderate magnifications. This lets you crawl through the nebula at your own pace and experience a dazzling variety of forms of glowing light. It's almost like a universe in itself.

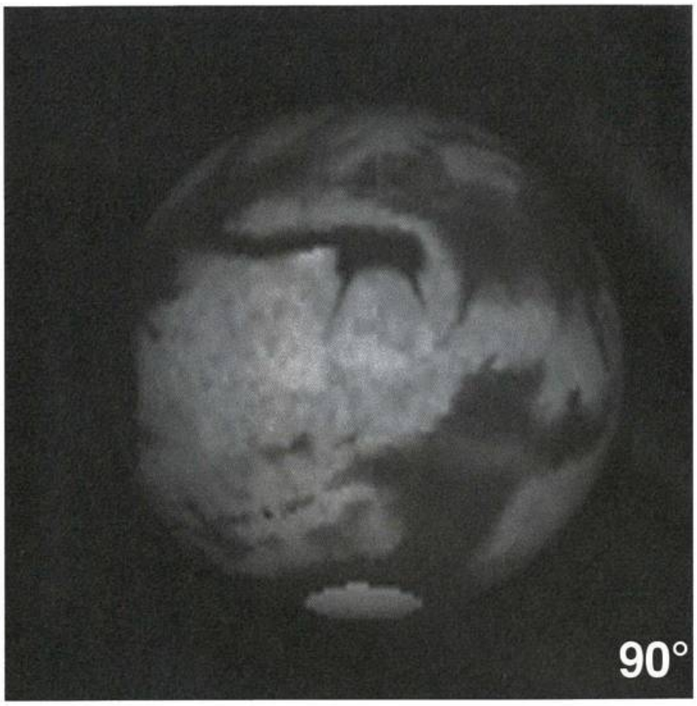
Orion also houses three other detailed nebulae. Planetary nebula **NGC 2022** is a smooth, bright glow surrounding its central star, a tiny little fellow exhausted of fuel and headed for the stellar graveyard. A real treat in the eyepiece, **M78** is one of the most easily visible reflection nebulae. A gray-green glow with an irregular shape, this object has several faint stars inside it. It's a dust cloud reflecting starlight to us rather than glowing on its own. Immediately east of the bright star Zeta Orionis, the emission nebula **NGC 2024** glows like a fluorescent bulb and shows remarkable detail in a big scope. A wide swath of dark nebulosity cuts across this object, separating it into irregular halves.

It's getting late, pal. If you've finished gawking at the residents of Orion, we'll move on to those springtime objects now rising high in the sky. Stuck in the stark star group Lynx, the 10th-magnitude globular cluster **NGC 2419** is a distant clump of several hundred thousand stars, at 300,000 light-years too distant to resolve. It looks like a bright, small core of light surrounded by a peppery haze, the unresolved light of nearly a million stars merging together over a wide gulf of space.

Farther southeast, in the constellation Leo, lies an even more remote target. The spiral galaxy **NGC 2903** shines magnificently through 20 million light-years of blackness. No, no — you keep looking, I'll start packing up. See those spiral arms nicely defined and surrounding the core of the galaxy, which appears like a big fat star? NGC 2903 is an Sb-type galaxy much like our own Milky Way, which soon will be rising in the east. Could you hand me that eyepiece? Thanks. No, keep looking. You're getting a view that few people on Earth ever see firsthand. I'm tired too, but keep looking. A 9th-magnitude sparkler, that one is. So you see how nice it is to use a big scope? That's okay; I'll drive. Yeah, an awfully nice view. An awfully nice view. ☐

David Higgins is an enthusiastic deep-sky observer living in Oklahoma and a frequent contributor.

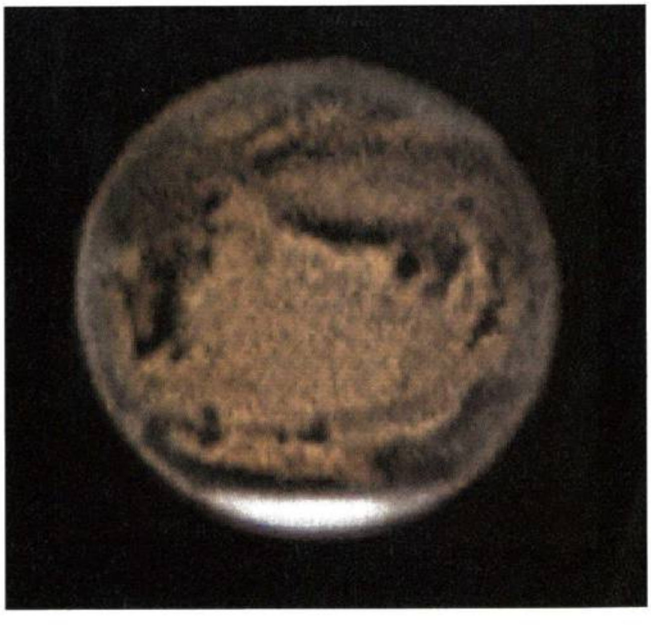




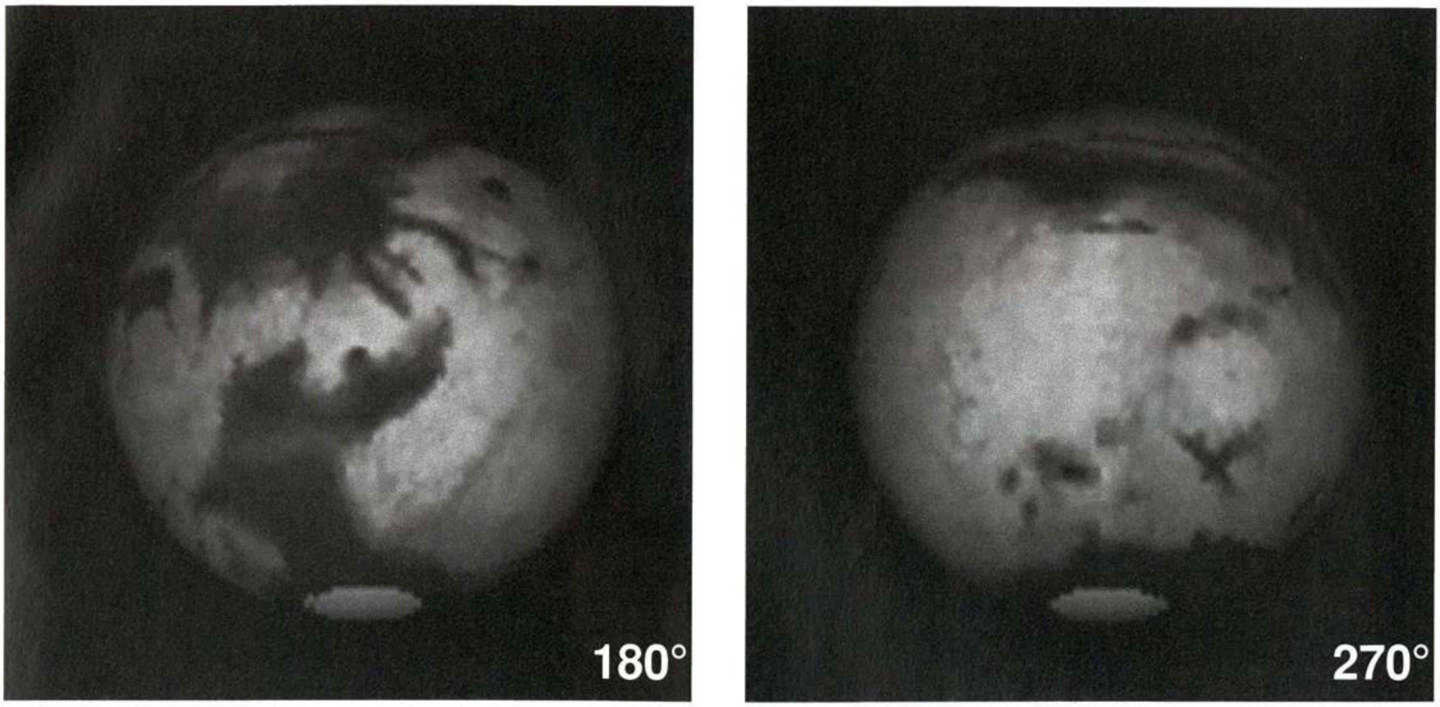
Discover the Red Planet

Now at its best in two years, Mars comes alive for every backyard astronomer who observes with the right tools and techniques.

by
Murray Paulson



CCD image by Don Parker, January 11, 1993



All drawings and map by Dan Troiani

ONE ROTATION REVEALS the varied features of Mars, as shown in this series of drawings made during the 1993 opposition. The Martian north polar cap lies at the bottom of the image.

Mars has always been an exciting observing target for many reasons. First, it has many Earthlike characteristics such as four seasons, polar caps, dust storms, and clouds. Second, about every two years Mars comes to opposition, rising at sunset and staying up all night, well-placed for telescopic scrutiny. It's around opposition that the Red Planet appears most striking in the eyepiece.

Unfortunately, not all oppositions are favorable and 1995's happens when Mars is about as far from Earth as it gets. This year's opposition, termed aphelic because Mars lies at its farthest distance from the Sun (aphelion), happens on February 11. At that time it lies 63 million miles from Earth and appears only 13.9" across in the eyepiece. The last time Mars was this small at opposition was on February 24, 1980.

But don't let that put you off observing it this winter, for there's still plenty to see. It's been 25 months since Mars was this close; it won't be this close again until 1997. Most of the time Mars hovers between 5" and 6". In that light, even an aphelic opposition is a Godsend. So arm yourself with a 4-inch or larger telescope, eyepieces that yield high power, and a set of colored filters, and prepare to observe the myriad features of the Red Planet.

Mars Viewing 101

A successful Mars observing session starts with the right eyepieces and magnification. Because Mars is small, observe at the highest power atmospheric steadiness allows. This will be 30x to 50x per inch of aperture. (If the magnification is too high, the image goes soft and you see less detail.) When using my 12.5-inch Dobsonian, I prefer a 4.7mm Ultra Wide eyepiece, which gives 340x. If the atmosphere is steadier, I use a 7mm Nagler coupled to a 2.4x Barlow, which yields 540x.

Wide-field eyepieces are especially helpful on telescopes without equatorial mountings because you can let Mars drift through the field of view for a longer period. On motor-driven scopes, the smaller fields of view in some eyepiece designs (such as orthoscopics or Plössls) matter much less. On my 4-inch refractor, for instance, my 8mm and 6mm orthoscopic eyepieces (combined with a 2.4x Barlow) yield powers of 192x and 256x and provide good viewing. The key, in any case, is to use the best eyepieces you have.

Magnification is important, but colored filters really make the difference when it comes to gleaning Martian detail, which is often subtle and low in contrast. Filters can improve the contrast between a particular feature and the disk of Mars. I recommend a full complement of standard Wratten filters because different colors bring out different Martian features. These are sold through mail-order dealers (see the advertisements in ASTRONOMY) and in telescope and photo stores.

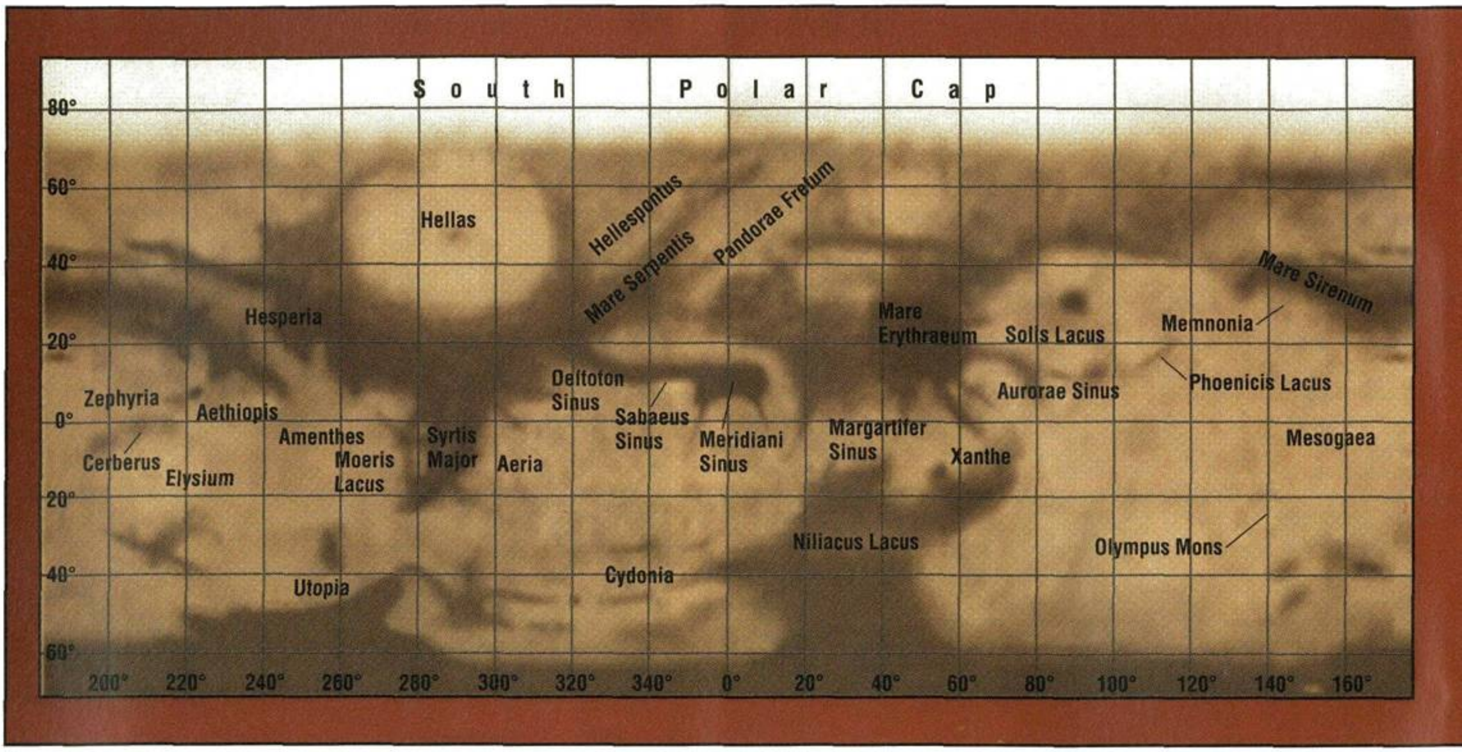
To observe dark markings, most observing experts recommend a red Wratten #25A. But in small telescopes this filter dims the image too much at high power. In these cases an orange filter (#21) works admirably to improve the contrast of Martian dark markings, while leaving images reasonably bright. If finances allow the purchase of only one filter, this should be it.

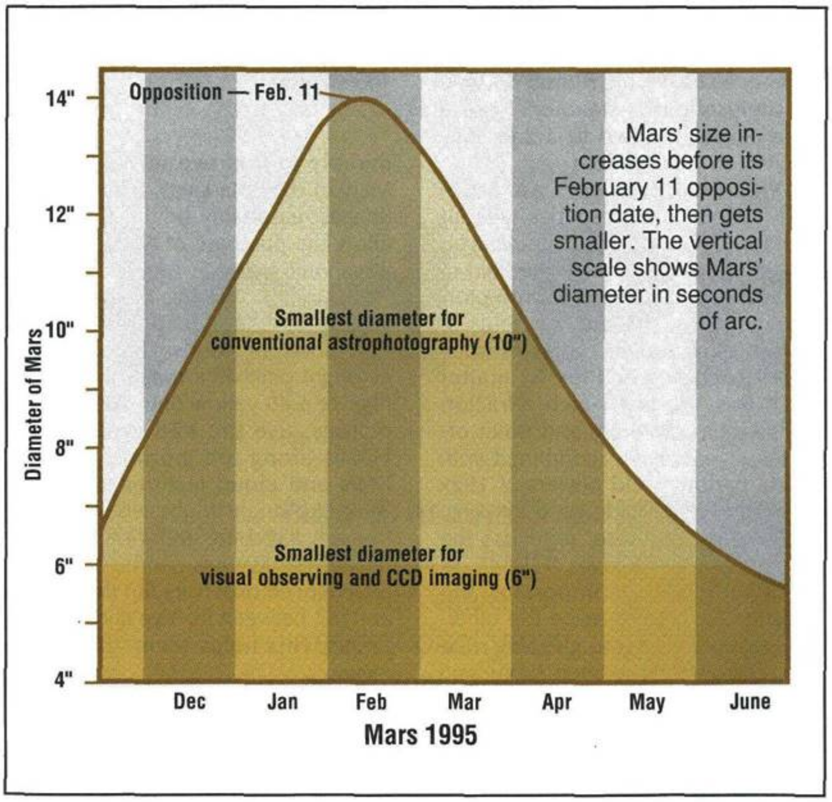
Besides observing dark features, you might want to patrol for Martian dust clouds or storms. These show up as bright patches through the orange filter or a #8 yellow one. To spot frost or fogs, use the #58 green filter. Hazes along the morning edge of Mars and cloud features anywhere look like bright blobs when viewed through #38 blue and #47 violet filters. These features can be subtle, so experienced observers flip the filter in and out between the eye and the eyepiece. This helps them "pop" into view.

Something in the Air

Even with the proper combination of telescope, eyepiece, filter, and magnification, air steadiness will make or break a Mars observing session. If there's a turbulent air column between your eyepiece and Mars, the planet's image will "boil" and show less detail than the telescope is capable of revealing. At times unsteady air makes the image look like a fuzzball, devoid of all details. But unsteady air can be beaten if you know where to look for the sources of bad seeing.

Tube currents. The moment a


South Polar Cap
80°
60°
40°
20°
0°
20°
40°
60°
Hellas
Hellespontus
Pandorae Fretum
Mare Serpentis
Mare Sirenum
Hesperia
Mare Erythraeum
Solis Lacus
Memnonia
Deltoton Sinus
Aurorae Sinus
Phoenicis Lacus
Zephyria
Aethiopis
Sabaeus Sinus
Meridiani Sinus
Margartifer Sinus
Mesogaea
Amenthes
Syrtis Major
Aeria
Xanthe
Cerberus
Elysium
Moeris Lacus
Niliacus Lacus
Olympus Mons
Utopia
Cydonia
200°
220°
240°
260°
280°
300°
320°
340°
0°
20°
40°
60°
80°
100°
120°
140°
160°



Mars' size increases before its February 11 opposition date, then gets smaller. The vertical scale shows Mars' diameter in seconds of arc.

warm telescope moves into the cold out-of-doors, air currents start to move within the tube. Hot air flows toward the top of the tube, while cold air sinks to the bottom. This air movement totally obscures details in the image. Tube current problems reveal themselves as slow-moving, swirling blurriness when the image is defocused. To lick this problem, set up the scope outside well ahead of time so it has time to cool. If you can't afford to wait, try using a fan to blow air through the tube. This speeds the cooling. Left unattended, my 12-inch Newtonian takes a few hours to reach the same temperature as the air outside. When I use a fan to blow air through the tube, it cools in about 30 minutes.

Nearby heat. Something radiating heat between the telescope and Mars generates turbulence. When setting up your telescope, avoid aiming it over warm roofs, chimneys, hot automobile engines, asphalt parking lots, and even other observers. (On occasion, my own body heat has degraded a planetary image.) In a defocused eyepiece, turbulence from nearby heat sources looks like a slow-moving river of blurriness.

Atmospheric steadiness. Atmospheric bad seeing can shut down useful planetary observing for days. Though not much can be done about Mother Nature's bad moods, you can stay alert for signs that she is relenting. Sometimes the turbulence is local, such as the area that surrounds an isolated cloud. Just wait it out; the rest of the sky may be sharp. If you notice fog or haze forming around you, don't put away the telescope! Some of the best observing is through light fogs and haze, when the moisture-laden air is ultra-stable.

When the seeing does steady, try your hand at drawing Mars. It's a good way to train your eye and learn the planet's geography. A drawing also serves as a permanent record of what you see. OK, your first attempts will look crude, but as you get more adept at recording features, drawings will appear more polished and contain loads of information. To get a feel for how large some of Mars' features are, draw the planet using a

Date	Central Meridian	Major Feature
Jan 8	87°	Solis Lacus
9	60°	Aurorae Sinus
12	33°	Mare Erythraeum
15	6°	Margaritifer Sinus
18	340°	Sabaeus Sinus
21	313°	Deltoton Sinus
24	287°	Syrtis Major
27	260°	Utopia
30	234°	Hesperia
Feb 2	208°	Elysium
5	182°	Zephyria
8	155°	Memnonia
11	129°	Olympus Mons
14	103°	Tharsis
17	77°	Solis Lacus
Feb 20	51°	Xanthe
23	25°	Mare Erythraeum
26	358°	Cydonia
Mar 1	332°	Sabaeus Sinus
4	305°	Aeria
7	279°	Moeris Lacus
10	252°	Amenthes
13	225°	Aethiopis
16	198°	Cerberus
19	171°	Mesogaea
22	144°	Mare Sirenum

This table lists the meridians that lie central on the Martian disk for 7 p.m. EST on the dates shown.

42mm circle. At this scale, each millimeter corresponds to 160 km (100 miles) on Mars. Don't forget to observe Mars using as many of the filters mentioned above as are useful under the conditions.

Regardless of whether you draw or just plain observe, the combination of Earth's and Mars' rotation makes it possible to conduct a leisurely "walk" across the Red Planet's face. Because the Martian day is 40 minutes longer than Earth's, each successive night you could see an additional 9° of surface creep onto Mars' disk on its eastern side. Thus if you observed at the same time each night, in the course of a little over a month, you'd see all of Mars.

A Stroll Around the Red Planet

During this apparition, Mars' northern hemisphere is experiencing local spring. The northern pole is tipping progressively toward the Sun and offering observers a rare chance to follow the shrinking of the north polar cap. Over the coming months, as the Martian northern hemisphere warms toward summer (which begins late in April), the prominent cap will evaporate to a fraction of its size at the beginning of the year.

When the polar cap shrinks, clouds often form above it. Use a green, blue, or violet filter to discriminate between the cap and clouds or haze. Also look for disconnected sections of the polar cap as it recedes. During previous oppositions, some observers have even glimpsed a feature called Rima Tenuis, a dark lane bisecting the cap. By May 1st, the north pole will be tipped 20° toward us (25° toward the Sun) and the cap will look like a tiny white dot.

After the white polar cap, the most prominent feature on Mars is Syrtis Major, near 290° longitude. This feature, which looks vaguely like the continent of Africa, was one of the earliest recognized on Mars. (A drawing of Mars made in 1659 by Christiaan Huygens shows it clearly.) Dark areas like Syrtis Major were originally thought to be seas like those on the Moon or areas of vegetation. Today we know they are merely rough expanses of dark lava that reflects less light than the bright areas, across which blow drifts of light-colored sand and dust (see "The Sands of Mars," June 1993).

A bright impact basin (some 1,700 kilometers in diameter) called Hellas lies south of Syrtis Major. Further west, near longitude 320°, is Mare Serpentis, which separates Hellespontus from Pandorae Fretum. These regions have fairly subtle contrast, but to the north lies unmistakably dark Meridiani Sinus (0°). Look carefully to see if any linear projections appear coming from this feature. Projections like these still foster the illusion of "canals" on Mars. Why? The human brain likes to see a continuation of linear features, and when details are subtle enough the imagination can easily run amok.

Moving west of Meridiani Sinus, it takes no imagination to see Mare Erythraem (30°), a region mottled with details. To its south lie the bright Argyre plains, another round impact basin which some observers have mistaken for a polar cap.

North of Meridiani Sinus is another dark feature, Niliacus Lacus. Look for its subtle mottling, bordered to the west by a lighter region. Continuing west, we come to Solis Lacus, the "Eye of Mars." This feature has a dark spot surrounded by bright plains, which creates the illusion of a giant eye staring back through the eyepiece. Look for it just south of the equator.

North of Solis Lacus lies one feature you won't see through a telescope, the huge Valles Marineris rift valley, discovered by Mariner 9 in 1971. This canyon system stretches 4,000 km and is 600 km wide. Not too far from here is Mars' largest volcano, Olympus Mons, which lies on an elevated plain called the Tharsis Bulge and shares the area with many other extinct volcanos. Use blue or violet filters to keep an eye peeled for morning mists and fogs. In 1954, E. C. Slipher was the first to see clouds forming over these volcanos. The clouds form when warm afternoon air rises over the tops of the volcanos and cools. He dubbed them "W" clouds after their shape.

Further on our journey, we come to the vast northern region, a lowland devoid of any features. To the south, however, lie the dark plains of Mare Sirenum (150°) and Mare Cimmerium (210°). There is a nice division between Mare Cimmerium and Syrtis Major that brings us back to the beginning of our tour around Mars.

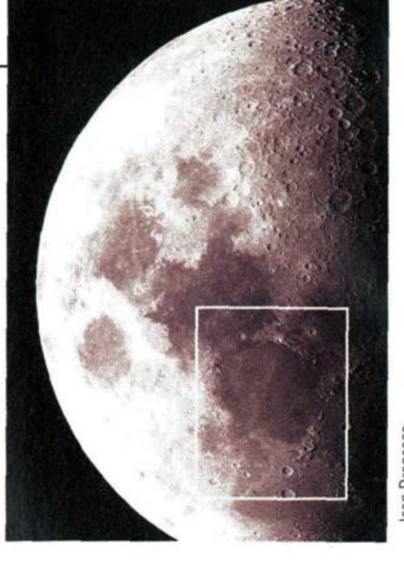
Some Martian features may look different in your eyepiece when compared to the map and drawings seen here. Mars' face changes with each apparition because its thin but dynamic atmosphere spreads dust all around the planet. It covers and uncovers features continually. You may be lucky enough to witness a sudden dust storm or see cloud activity near the volcanos.

Observing Mars night after night is quite a rewarding experience in light of these long- and short-term changes. Enjoy the show it presents to you this opposition, for it will have changed by the next one. ☐

Murray Paulson is an avid planetary observer from St. Albert, Alberta. He made his first Martian observations as a teenager during the early 1970s.

MOON OBSERVER'S NOTEBOOK

SAILING THE SEA OF SERENITY



Jean Dragesco

A VAST SHEET OF ROCK filling an even larger impact basin, Mare Serenitatis is a highly rewarding part of the Moon to explore with a backyard telescope.

Mankind last set foot on the Moon on the shore of the Sea of Serenity; it's a place that offers telescope owners a look at some of the Moon's most varied features.

by Robert Burnham

A large, nearly circular patch of dark ground forms the eastern eye of the Man in the Moon. This is the Sea of Serenity or to give its proper name, Mare Serenitatis. When Franceso Grimaldi named this feature on his early lunar map (published in 1651 by Giovanni Riccioli), he probably knew as most astronomers did even then that these big flat expanses on the Moon weren't really seas of water, but vast plains of rock.

Whimsy or not, the naming scheme publicized by Riccioli soon prevailed over rival ones, and thus Mare Serenitatis ended up surrounded by features similarly named. To the south, for example, lies the Sea of Tranquility (Mare Tranquillitatis) while the Sea of Rains (Mare Imbrium) stands to the west; flanking it to the northeast is the Lake of Dreams (Lacus Somniorum). The Sea of Serenity really is an appropriate name: Nothing much has happened here since the day 109 million years ago when the Tycho impact splashed a ray of bright debris across the mare, just missing the 16-kilometer crater Bessel.

Mare Serenitatis is a sheet of lava rock with about the same area as Arizona or New Mexico. Lunar geologists carefully distinguish the 600-kilometer-wide mare (pronounced MAH-ray) from the broad, shallow impact basin it lies within, whose rim spans about 740 km. Scientists think the basin was created by the impact of an asteroid some 3.87 billion years ago, a time in lunar history when big impacts were common. The mare lava, though, is some 150 to 200 million years younger, and its surface has subsided about 3 to 4 km below lunar "sea level," the Moon's average radius. The basin rim was once essentially a full circle, but later events (in particular the Imbrium impact) broke its continuity. Thus today we see Serenitatis bordered by apparently separate mountain ranges. These are the Caucasus in the north, the Taurus to the east, and the Haemus to the south, which merges into the Imbrium basin's Apennines on the west.

At first glance in a backyard telescope, Mare Serenitatis appears just a broad expanse of gray. But a closer look reveals many tint variations and topographic features. Around lunar sunrise — about five days after New Moon — when the terminator (the line between lunar day and night) crosses the mare, what strikes your eye most strongly are the patterns of knotted ridges roughly outlining the mare's circular shape. These lie like wrinkles in the cupped palm of your hand and are in fact called wrinkle ridges. The largest is the so-called **Serpentine Ridge**, which meanders for 130 km along the mare's eastern side.

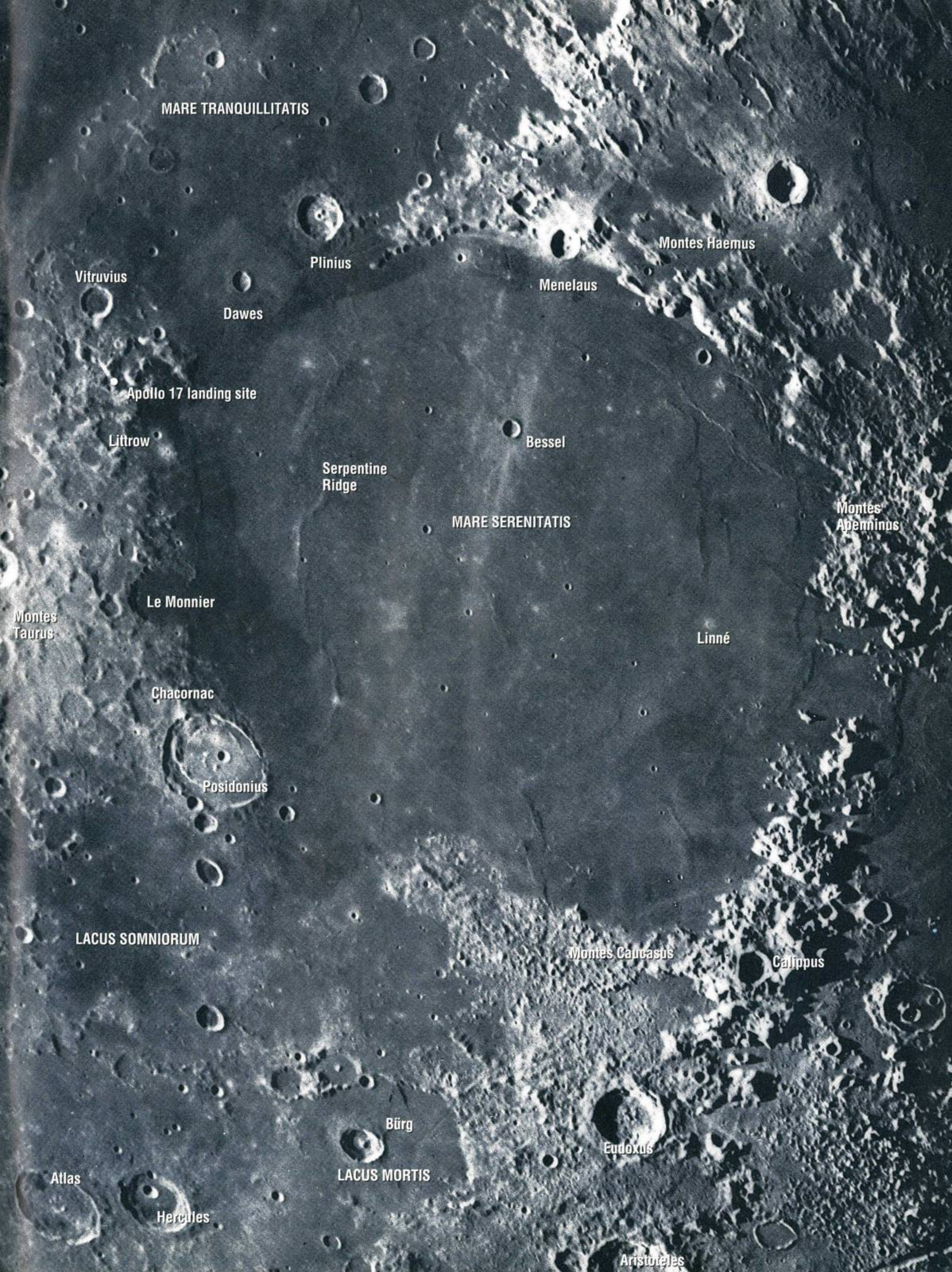
Wrinkle ridges result when the mare surface subsides and many betray the locations of buried basin rims or rings. A radar sounder on the Apollo 17 command module showed the bottom of the Serenitatis basin lies 1,500 meters below the mare surface in the west and 2,000 m deep in the east. The radar also revealed that the mare has an internal layer about 1,000 m down. This buried horizon may be evidence that Mare Serenitatis filled in two distinct episodes.

As the Sun rises higher, you can easily see that the mare's eastern and southern edges have a distinctly darker shade, and that this dark material penetrates a considerable distance into the bordering mountains. Geologists once thought this dark material, which is lava rich in iron and titanium, was younger than the light gray lavas of the mare's center. But Apollo 17 samples and careful study of the number of craters seen in photos from lunar orbit showed that it is actually older.

The largest crater in the south, **Plinius**, spans 43 km and is 2,300 m deep. Standing in the 100-km-wide "strait" between Serenitatis and Tranquillitatis, Plinius is nicely terraced inside and sports an odd central peak that under sunrise conditions looks like a double crater. Three parallel rilles slice across the dark mare north of Plinius and other sets continue along the shore toward the west. Their curving form (which parallels the basin rim) and flat floors suggest they are grabens that cracked open as the mare surface subsided, perhaps under the weight of the brighter lavas that spilled out in the mare center.

On the western side of Serenitatis, a 50-km-wide strait chops a path into Mare Imbrium between the Apennine and Caucasus Mountains. Examine the strait under grazing light and you'll see several soft-looking scarps that help trace the underlying basin rim. The history here is tangled. After

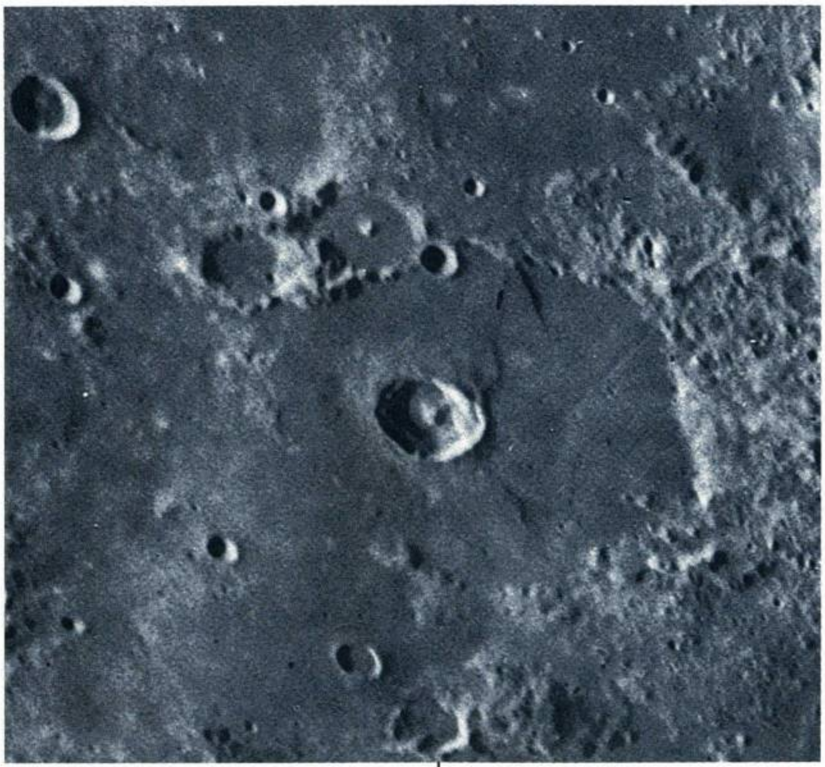
Lick Observatory


MARE TRANQUILLITATIS
Montes Haemus
Plinius
Menelaus
Vitruvius
Dawes
Apollo 17 landing site
Littrow
Bessel
Serpentine
Ridge
MARE SERENITATIS
Montes
Apenninus
Le Monnier
Montes
Taurus
Linné
Chacornac
Posidonius
LACUS SOMNIORUM
Montes Caucasus
Calippus
Bürg
Eudoxus
Atlas
LACUS MORTIS
Hercules
Aristoteles

much study, geolgists think the Serenitatis basin formed first, then an asteroid excavated the Imbrium basin. Only then did the Serenitatis lavas emerge to fill their basin, followed by those of Imbrium.

Now use high power and look a short way out into Serenitatis for a tiny (2.5 km) solitary crater. **Linné** is apparently a fresh impact crater with a bright blanket of ejecta surrounding it. Under most conditions, all you will see of Linné is the bright spot. When 19th-century astronomers confused the ejecta's diameter with that of the crater itself, they were misled into thinking that Linné had recently changed in size. Alas, too bad for lunar fantasies. As spacecraft photos have shown, Linné, while young in lunar terms, is nonetheless millions of years old and utterly normal in origin.

Running north from the strait, the Caucasus Mountains define the northwest rim of the Serenitatis basin. Like the Apennines, these contain pretty tall peaks: up to 6 km above the mare plains. The craters within the mountains — 33-km **Calippus**, 67-km **Eudoxus**, and 87-km **Aristoteles** — postdate the basin-forming impacts and have been extensively modified inside by slumping and pooling of impact-melted rock. In Eudoxus and Aristoteles particularly, impact melt has all but swallowed their central peaks. Collapse of their walls on the inside has left both with intricate networks of terraces and landslides for you to explore by telescope.



Lick Observatory

THE LAKE OF DEATH, Lacus Mortis, is actually a large, old impact crater flooded to the brim with the lavas of Lacus Somniorum. The small crater in the center is Bürg.

The Caucasus range also forms the northern shore of Serenitatis. But its arc is broken in the northeast where the mare lavas burst though the basin rim to flood a large region beyond. This is **Lacus Somniorum**, the Lake of Dreams. Somniorum has a huge area — in fact, it's bounded more by mapmakers' convention than physical features since it flows on contiguously into Mare Frigoris. Farther to the east, dark lava can be seen to underlie much of the landscape between Serenitatis and the Moon's northeast limb. Lunar geologists call this kind of terrain "cryptomare," and it's especially rewarding to hunt for at times of high Sun angle, such as gibbous or Full Moon. (Use a neutral gray filter to reduce the glare.)

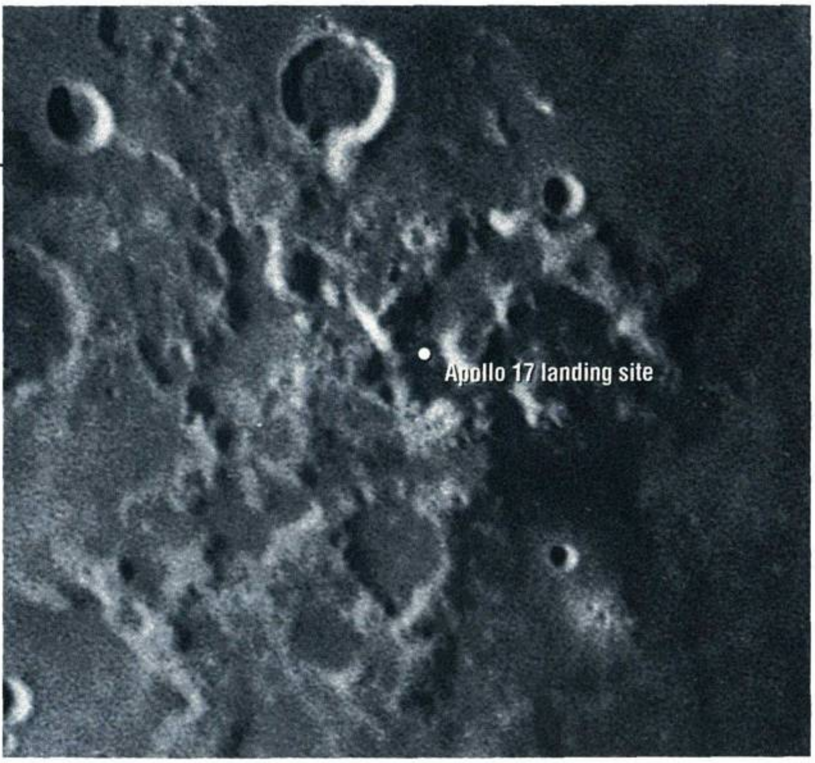
In a telescope, Lacus Somniorum abounds in peaks and crater walls half drowned by lava flows. You can almost write a history of the region yourself by noting the relative state of degradation in its craters. Many small, unnamed craters appear barely altered and are presumably fresh. At the other extreme, **Lacus Mortis**, the Lake of Death, is so flooded that it no longer deserves the name crater. Lacus Mortis is a ring of peaks 150 km across, marking the topmost rim of an impact crater so ancient that it's almost obliterated. It must have formed during the millions of years that divided the creation of the Serenitatis basin from its mare infill. The 40-km crater **Bürg** stands in the center of Lacus Mortis, relatively new and startlingly fresh by contrast. Once your eye gets the hang of it, you'll see many more faint features whose circularity (full or partial) points toward an impact origin obscured by lava floods.

Lick Observatory

POWERFUL GEOLOGICAL FORCES compressed the surface, pushing up the Serpentine Ridge when the basin under Mare Serenitatis subsided.

On Mare Serenitatis' eastern shore lies one of the Moon's most remarkable craters, **Posidonius**. Over 95 km in diameter and 2,300 m deep, Posidonius once must have been a much deeper pit than it is today. Its floor, which tips gently toward the north, now lies at practically the same level as the adjacent mare. But it differs markedly in color and tint, both of which point to a difference in composition. Multispectral studies from Earth and with spacecraft show that whatever its detailed properties are, the floor of Posidonius shares the

THE FIRST TIME IS TRICKY but once you pinpoint it, the Taurus-Littrow valley where Apollo 17 landed stands out because it is so dark.

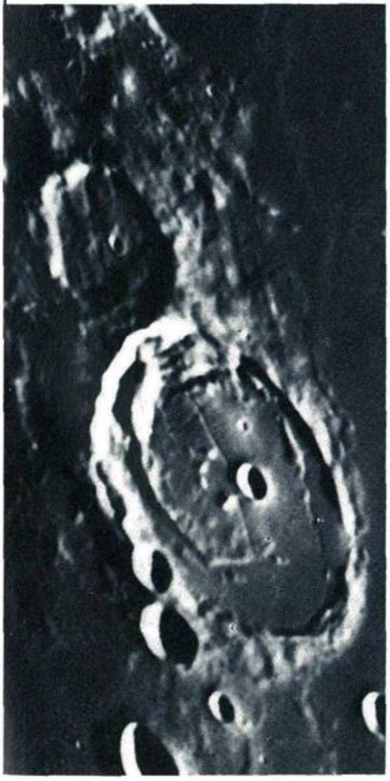


Lick Observatory

spectral characteristics of the Taurus Mountains rather than the nearby mare. Thus it is probably a pool of impact melt derived from the target rocks rather than a portion of mare that seeped into the crater.

When conditions allow it, turn the highest power your telescope provides onto Posidonius. You'll have to look for them, but this crater actually has central peaks. They are often overshadowed by the long ridge that meanders in a spiral path from the inside southeastern wall. Another ridge on the southwestern floor faintly echoes the main one. Most likely the ridges are the top edges of gigantic slump-terraces, with the rest buried by floor material. A network of rilles crisscross the crater floor, popping into view and vanishing again as good seeing comes and goes. Easiest to spot is the long rille that nearly bisects the floor; several smaller and shallower ones cross it in the southern part of the floor.

CRACKED WITH RILLES, the floor of Posidonius offers much geological detail for telescopic explorers.



Lick Observatory

Posidonius' companion on the south is the crater **Chacornac**. Some 50 km across, this is a fairly respectable crater, but it suffers from comparison to its more vivid neighbor. Somehow, Chacornac strikes the observer as old. Its features (except for 8-km Chacornac A in its center) look subdued and almost weathered. Several graben rilles slice through the Taurus Mountains here and continue across Chacornac unhindered. Ironically, the crater **Le Monnier** is in much rougher shape, but it's a lot more noticeable because it straddles the shore of the mare. Making a deep bay in the mountains, Le Monnier stretches 60 km and was the landing site (in January 1973) for the Soviet Luna 21 probe and its remotely controlled rover Lunakhod 2. Le Monnier's floor is featureless, except for a wrinkle ridge across its mouth.

No backyard lunar explorer should leave the Sea of Serenity without paying a visit to the little valley where mankind last set foot on the Moon. The **Apollo 17 landing site** was designated Taurus-Littrow, but the name isn't a lot of help in finding it. Scan south along the shore from Le Monnier, noting the wrinkle ridges and rilles caused by the mare's subsidence. When you reach **Littrow** crater (30 km across), shift to a medium-power eyepiece and look carefully one Littrow-diameter south of the crater, about halfway between Littrow and **Vitruvius**. The floor of the valley the astronauts landed in is very dark — so dark that Full Moon isn't a bad time to look for it. The valley is roughly square in shape and looks like a portion of dark mare trapped among the massifs of the Taurus Mountains — which is just what it is.

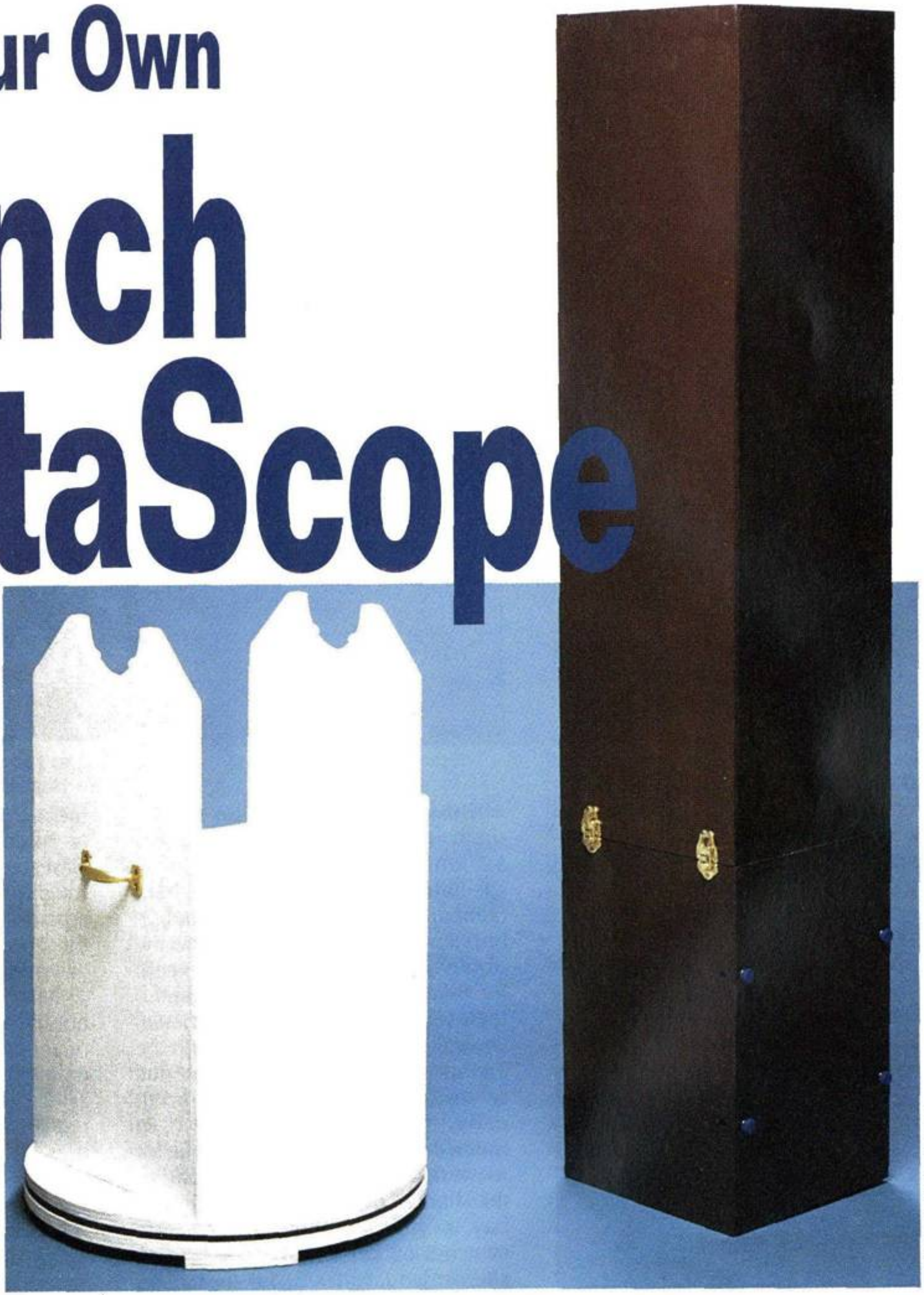
Mission planners chose the site hoping the dark color was evidence of recent volcanism. But despite a momentary surge of hope when the astronauts found orange glass on the rim of a small crater, the valley floor basalts proved to be 3.72 billion years old. (The celebrated glass unfortunately turned out to be old after all.) A lot more exciting was finding ejecta from the Tycho impact. The fact that Tycho debris landed at Taurus-Littrow, some 2,250 km from the impact site, speaks volumes about the violence of a major crater impact! (After one of the much larger basin impacts, such as Serenitatis itself, every part of the Moon must have received at least a light sprinkling of rocks.)

Taurus-Littrow marked an end; where and when human lunar exploration may recommence is very much a matter of debate. Still, the vast amount of data from the Clementine mission offers much to study and correlate with mineralogical studies of Apollo samples. The beauty of the Moon is manifold: It lies nearby in space, so it's easy to send missions there. And it also lies perfectly within reach of every backyard astronomer. ☐

Build Your Own 10-inch PortaScope

This two-part series gives step-by-step instructions for building a mid-sized scope that breaks apart for easy transport.

by David Bruning



ASTRONOMY: Darla Evans

The PortaScope is a great project for backyard astronomers wanting their first telescope or wanting to move up in aperture. It features a 10-inch mirror for viewing faint deep-sky objects, a partially baffled tube for good image contrast, a 2" focuser for use with wide-angle and ultra-low power eyepieces, a two-piece tube for portability, a door for easy access to the mirror for cleaning, and a novel mirror mount for easy collimation. To keep the scope simple and inexpensive, it uses an altazimuth mount popularized by John Dobson.

With the low prices of Dobsonian scopes sold by several manufacturers, why build a scope? When you purchase a scope from a manufacturer, you buy convenience. After a couple of simple assembly steps, the scope is ready to take outside for your first observing session. But unless you think exactly like the manufacturer, the scope isn't customized to your preferences. By making your own scope, you can fit it with exactly the features you want.

Gone are the days when amateur telescope makers ground their mirrors and cast telescope mounts in metal. Now they can choose from a number of high-quality parts with which to assemble a scope. The PortaScope costs about $625 to build, complete with a Telrad finder and a good-quality eyepiece, comparable to the cost of a manufactured scope without a finder. With the expenditure of some time (about 50 hours), you can build a scope with more features than a commercial scope and one that will perform at least as well, if not better. And don't forget the pride of telling friends that you built it yourself and the pleasure of watching a stack of lumber turn into an instrument that can capture the light of a galaxy millions of light-years away.

PortaScope uses several purchased parts: primary mirror, diagonal mirror, diagonal holder and support, focuser, and finderscope. The scope has three owner-built parts: tube, altazimuth mount, and primary mirror cell. Part one of this series covers constructing the tube and mount, and part two, in next month's issue, describes building the mirror cell, installing the diagonal, focuser, and finderscope, and collimating the scope for its "first light" observing session.

ASTRONOMY: Chris Becker

PURCHASE HARD-TO-BUILD PARTS, such as the diagonal mirror (clockwise from left), diagonal mirror holder, primary mirror, Telrad finderscope, 2" focuser, eyepiece, and 1 1/4" eyepiece adapter.

Laying Out a Design

The PortaScope uses an f/5.6 mirror to keep the tube short (an f/4.5 mirror with an 11" shorter focal length is also available). To shield the eyepiece from stray light, the tube is overly long (about a tube diameter or 12" past the diagonal mirror). Several internal baffles reduce scattered light in the tube. The tube has about an inch of clearance around the mirror to help ventilate the tube and remove heat from the light path. Turbulence in the tube is one cause of bad seeing, or blurring of an image formed by otherwise good optics.

To avoid cutting off the light in the corners of wide-field views (vignetting), the scope uses an elliptical diagonal with a 2.6" minor axis. This is 26 percent of the primary mirror's diameter, which might be unacceptable to observers wanting extremely high contrast. Substituting a 1 1/4" focuser would permit a 1.83" diagonal and provide higher contrast for viewing details on planets and in faint nebulae and galaxies. If some vignetting is tolerable, a 2.14" diagonal would provide slightly higher contrast views with the 2" focuser.

As with all Dobsonians, the base of the telescope also forms its altazimuth mount. The scope rocks up and down on two flanges that sit in cutouts in the sides of a three-walled box. The rocker box, in turn, rotates on top of a board that rests on the ground.

Before ordering parts and cutting wood, decide what you want from a scope. For example, if your observing needs are modest or you want a scope lighter in weight, an 8-inch mirror might be adequate and would save $100. Use of a 1 1/4" focuser allows a smaller diagonal and saves at least $35, not to mention the savings on eyepieces. Some backyard astronomers prefer a rack-and-pinion focuser but it can cost twice as much as the helical focuser used in the PortaScope. Other astronomers prefer the magnification of an 8x50 finder over the nonmagnified view of a Telrad, spending an extra $60 for this type of finderscope.

Check the ads in ASTRONOMY and get some catalogs from dealers that sell telescope parts. Spend a few nights exploring options before committing to one accessory or another. It's easier to change the design of the scope before you've started — or finished — construction. Once you decide on the primary mirror size, diagonal size, focuser size and type, and a finderscope, order these parts right away. It's not uncommon to encounter a three- to six-month backorder for at least the primary mirror. Wait until all the parts have arrived before starting construction so you won't have any surprises about actual dimensions.

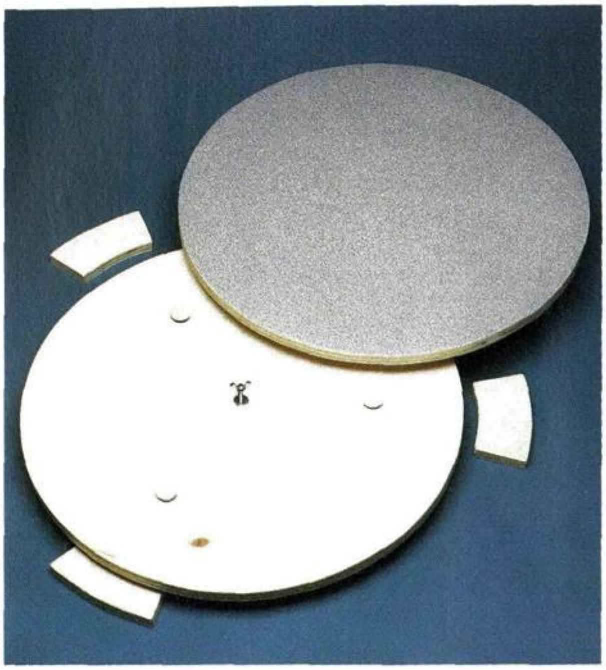
If you're designing and building a scope from scratch, you should assemble the tube first. That enables you to install the mirror, focuser, finderscope, and diagonal and then find the balance point along the length of the tube so you know how high to make the sides of the rocker box. But the dimensions of PortaScope are already known, so we'll start with the mount.

Ups and Downs of Telescopes

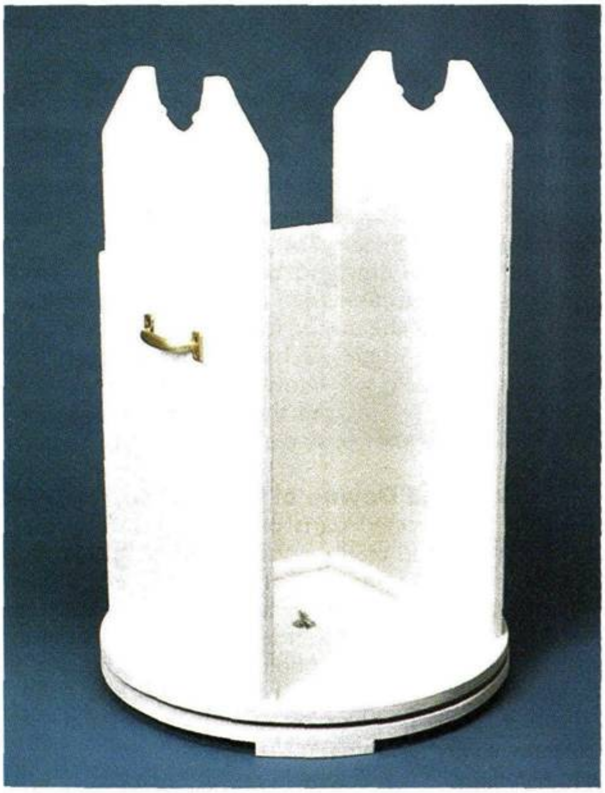
All the constructed parts use plywood. (Particleboard is heavy and OSB or waferboard is hard to finish.) To prevent delamination of the plies, use an exterior-grade plywood. The choice of grades is up to you: B/C or A/C is easier to finish than a C/D product, but the inside of the tube should be rough to help trap scattered light.

For the rocker box base and ground board, cut two 22"-diameter circles from the 3/4" plywood using a saber saw. A nail and a pencil taped to a yardstick can substitute for a beam compass to mark the circle. You could make these square, but circles prevent catching a toe on the ground board in the dark. The disks need not be precisely circular but you can match the edges, if you wish, with a Surform file.

From scraps of the 3/4" plywood, cut three feet for the ground board about 5" across and 3" wide. These can


ASTRONOMY: Chris Becker

THE AZIMUTH BEARING USES two disks to turn the scope side to side. The bottom disk is the ground board and has three nylon pads that the top disk slides over with its plastic laminated bottom. The top disk also forms the base for the mount's rocker box.


ASTRONOMY: Darla Evans

THE ROCKER BOX ACTS as the altitude bearing. Nylon pads nailed in the half circles at the top of the rocker box support the closet flanges mounted on the telescope tube (done in part two of this series). Together, the nylon pads and closet flanges allow the scope to move up and down.

be any shape but I cut the 5" sides as concentric circles of 11" and 8" radii so the feet would be flush with the outer edge of the ground board. Attach each foot to the bottom of the ground board with glue and two $1^1/_4$" screws.

Traditionally, Dobsonians use nylon and a plastic laminate (Formica or other brands) for the azimuth bearing surfaces. The idea is to make the scope turn easily with a gentle shove but not so easily that a light wind will push the scope out of position. Large Dobsonians need more slippery Teflon to make turning easy. But for the weight of this scope, cheaper nylon should work well. If you find that the scope doesn't turn easily, you can always substitute Teflon for the nylon. (Scrap Teflon is available from many plastic dealers; see "Plastics" in the phone book.)

For the nylon surface, nail three 1"-diameter chair gliders onto the ground board 120° apart. The gliders have built-in nails so the nail heads won't score the laminate.

The plastic laminate covers the bottom of the rocker box base. Just be sure that it's not textured so the nylon gliders will slide easily over its surface. Get a piece about 24" x 24" to avoid having to align the sheet carefully on the disk. The excess will be trimmed later.

Use contact cement to attach the laminate to the disk. Spreading the cement evenly with a brush, apply some to the disk and some to the bottom side of the plastic. You may need to roughen the surface of the plastic with sandpaper before applying the cement (see the manufacturer's instructions). After about 30 minutes, the cement takes on a glossy sheen that means it's ready to stick together. Place some scrap wood pieces on the disk so the laminate can't accidentally touch — and adhere to — the disk. Once the two objects touch, the contact cement won't easily release them.

Center the laminate roughly over the disk and remove the sticks one at a time, pressing the plastic onto the contact cement. After removing all the sticks, press the plastic firmly onto the disk. Once dry, trim the plastic with a sharp utility knife. Finish the edge with a fine-toothed file, keeping the file at a 45° angle to prevent chipping of the laminate later.

Drill a $^5/_{16}$" hole in the center of both disks. Insert a $^5/_{16}$" carriage bolt first through the ground board and then through the rocker base. Place a washer over the bolt and secure lightly with a wing nut so the disks can still rotate freely.

The rocker box needs to be slightly bigger than the tube. Figuring that the tube is 13" square and various hardware sticks out about $^1/_2$" on all sides, the inside dimension needs to be at least 14". So cut two $14^1/_2$" x 30" sides from $^3/_4$" plywood. Cut a half circle, about $5^1/_2$" in diameter, centered along the top of each side piece. (This supports the altitude bearing, a closet flange of 5" actual diameter.) The top corners can be cut back at a 45° angle to prevent bumping a leg into a sharp corner. The front piece, a $15^1/_2$" x 20" piece of $^3/_4$" plywood, supports the two sides. This piece is shorter than the sides to allow the scope to point near the horizon.

The joints of the box require gluing blocks because fasteners screwed in the edge of the plywood won't hold. Oak quarter-round molding makes useful glue blocks. Glue and fasten the blocks to the front and bottom edges of the two side pieces with $1^1/_4$" long screws. It's the glue that holds the joint together, so three screws

Parts List for the PortaScope

1 or 2	4' x 8' plywood, 1/2" thick (see text on tubes)
1	4' x 8' plywood, 3/4" thick
1	2' x 4' plywood, 1/4" thick
1	1x2 pine, 4' long
1	1x4 pine, 4' long
4	3/4" quarter round oak molding, 8' long
1	3/4" dowel, 6" long
1	24" x 24" plastic laminate, smooth surface
2	4" closet flanges, choose ones with sturdy walls
2	5 1/2" garage door handles
4	draw catches (with 1/2" screws)
1	5/16" carriage bolt with washer and wing nut
4	1/4x20 bolts, 1" long with knob
4	1/4" washers
4	right-angle joint connectors for 1/4x20 bolts
6	1"-long 8x32 machine screws with washers and nuts
3	1"-diameter nylon gliders
4	3/4"-diameter nylon gliders
6	1 1/2"-long #6 flathead wood screws
24	1 1/4"-long #6 flathead wood screws
62	1"-long #6 flathead wood screws
48	3/4"-long #17 wire nails
	gloss enamel paint, exterior grade
	flat black paint, exterior grade
	carpenter's glue, exterior grade
	contact cement
1	10-inch f/5.6 primary mirror
1	2.60" elliptical diagonal mirror
1	diagonal holder and spider support
1	2" low-profile, helical focuser
1	finderscope, such as a Telrad
	assorted eyepieces (See the section on eyepieces in the 1995 *Observer's Guide.*)

per block should suffice to hold it until the glue dries. Drill pilot holes for the screws; they're especially needed because of the hard oak. Attach the front support piece to the front edges of the side pieces using glue blocks. Check that the sides are square using a carpenter's square.

Center this three-sided box on the disk with the laminate facing down. Glue the blocks to the base and drill pilot holes for the screws through the blocks and into the base at a 45° angle. Use two 1 1/2"-long screws to fasten the box to the base. Screw a glue block to the bottom of the front support board and attach it to the base for additional strength.

On one of the half circles cut from the top, mark two lines at 45° from the straight edge. The lines should go through the center of the circle and make a 90° angle with each other. Use this template to locate two 3/4" gliders in each half circle and nail them in place.

Use a file and sandpaper to round the edges of the rocker box and the top edge of the base disk. This will prevent splinters and make the box easier to handle. The base is relatively light (27 pounds) and easy to carry. But mounting a 5 1/2" garage-door handle on each side of the box about 17" above the base disk makes lifting the mount from the car trunk or carrying it from the garage to the observing site even easier.

Tubular

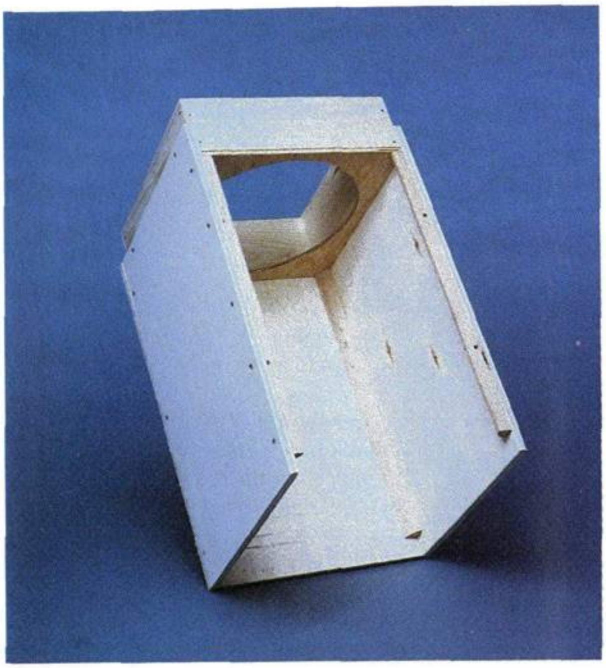
With the mount finished, the remaining major assembly is the tube. A 10-inch mirror and 1" clearance around the mirror requires a tube with an inside dimension of 12". The PortaScope tube uses 1/2" plywood for rigidity with minimal weight, which means the outside dimension is 13".

Now to determine the tube's length. Find the focal length of the mirror (usually written on the mirror's back; 56 inches for the PortaScope). The diagonal-to-focus distance is the tube radius (outside dimension of the tube) plus the height of the focuser plus one-half the focuser travel. The helical focuser is 1 5/8" high and has 1 3/4" of travel. So for the PortaScope, the diagonal-to-focus distance is 6.5" + 1.625" + 0.875" = 9". The tube length is the mirror cell thickness (including the mirror) plus the focal length minus the diagonal-to-focus distance plus the inside tube diameter (3.5" + 56" − 9" + 12" = 62.5"; 64" in the actual design).

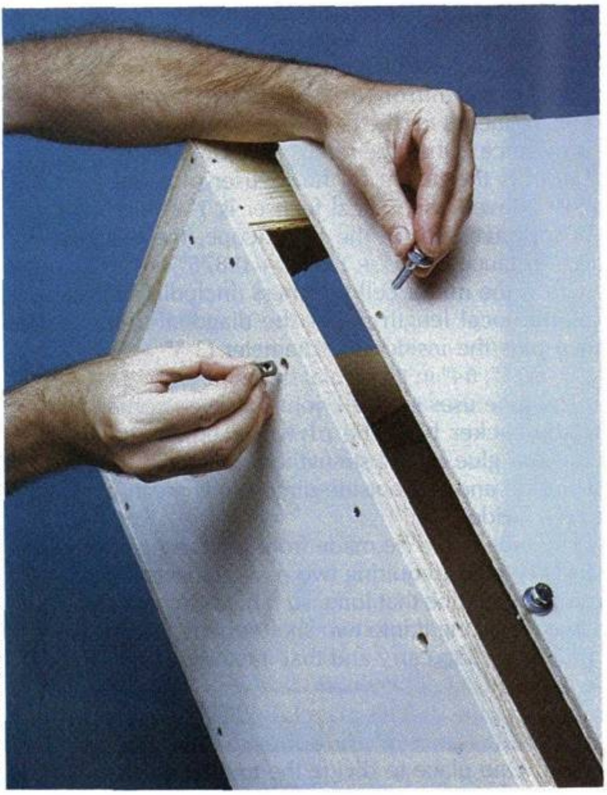
The tube uses simple L joints at each corner. Just as for the rocker box, the plywood edges won't hold screws so glue blocks strengthen each joint inside. The 12" inside and 13" outside dimensions mean each side is 12 1/2" wide.

The tube could be made from four sections of 12 1/2" x 64" plywood (requiring two 4' x 8' sheets). Some cars won't hold a tube that long, so it helps to break the tube in two. Breaking it into two shorter parts also means the tube is lighter to carry and that it can be cut from a single 4' x 8' sheet of plywood.

Much of the scope's mass is in the primary mirror, so the bottom fourth of the tube holds about half the weight. One place to divide the tube is about 20" from the mirror end. That puts the altitude bearings on the upper part of the tube, which means that the tube must be assembled before placing it on the mount. A second possibility is to break it around 30" so the altitude bearings attach to the mirror box. To assemble the scope, the mirror box would be placed on the mount and then

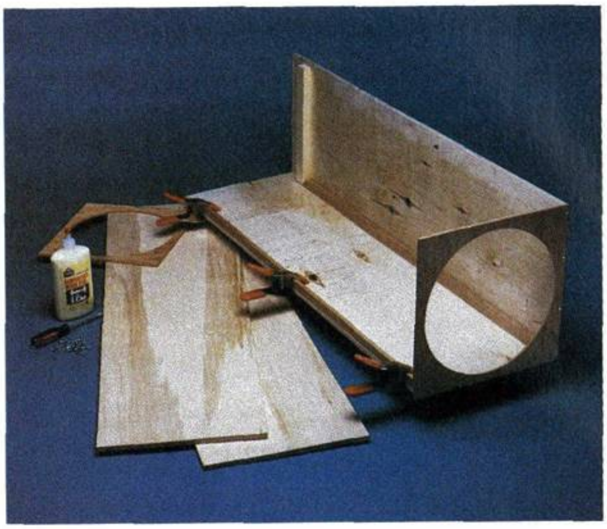


THE MIRROR BOX HOUSES the primary mirror. The collar at the top of the box joins the two tube sections together. It also holds one of four baffles in the scope. Because end grain doesn't hold screws very well, the PortaScope uses glue blocks to strengthen the L-jointed sides.



Photos on both pages by Darla Evans, ASTRONOMY

GETTING TO THE PRIMARY MIRROR for cleaning is easy because one side of the mirror box comes off. Knob-headed bolts and special right-angle fittings make access quick and simple. These fittings are available at many hardware stores.



THE FRONT BAFFLE HELPS SQUARE the top section of the tube. As in the mirror box, glue blocks strengthen the L joints. A 1x2 collar near the mirror box end holds the second baffle in this section.

the upper portion of the tube attached. The PortaScope uses the shorter and lighter mirror box.

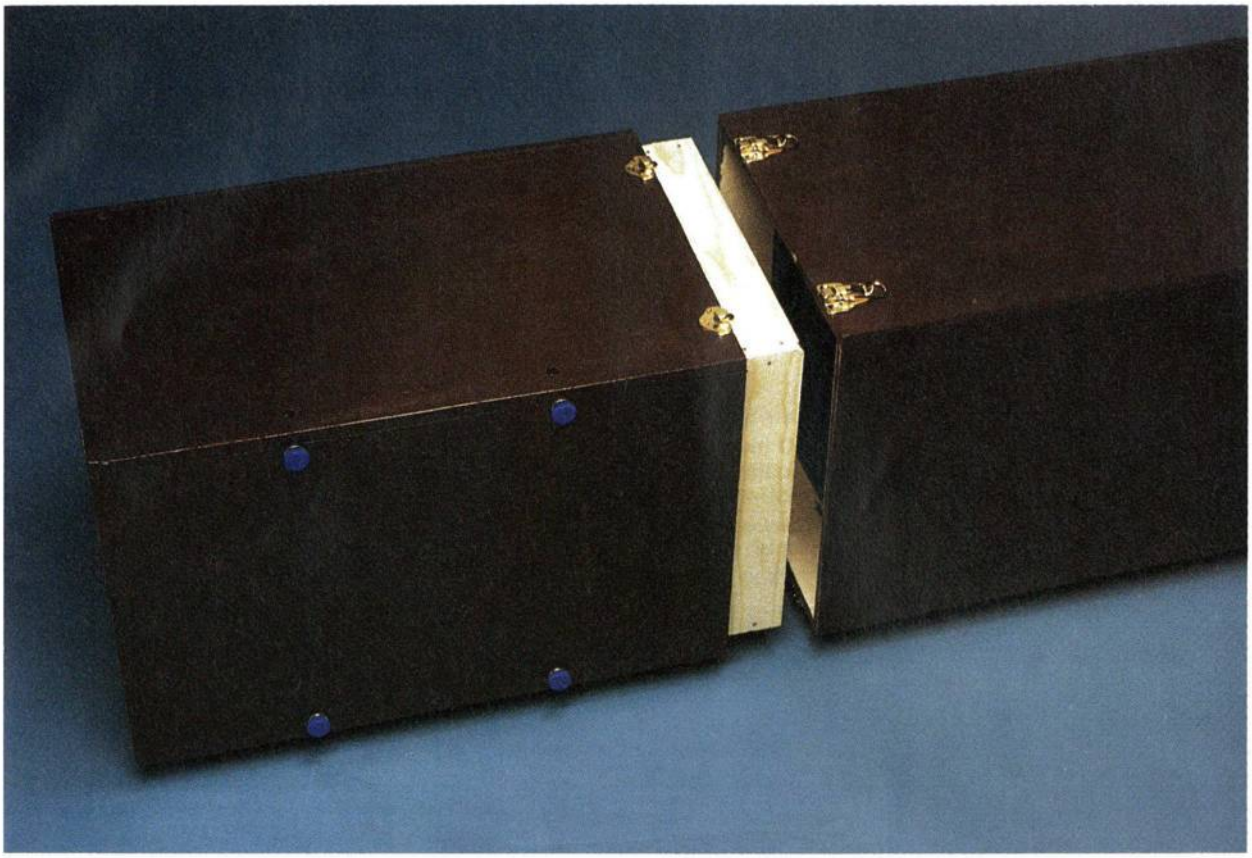
For a two section tube, cut four 12½" x 20" pieces and four 12½" x 44" pieces of ½" plywood. A table saw makes cutting these pieces easy, but a circular saw and 4' saw guide will also work. Using glue and 1" long screws, fasten glue blocks to one edge of three 20" pieces and all four 44" pieces. The glue blocks are 17" long for the 20" pieces and 40" long for the other sections. Again, it's the glue that holds the joint together, so three or four screws should suffice to clamp the joint until the glue dries.

Next glue and screw the three 20" pieces together. Use a carpenter's square to check that each angle is 90°. Bar clamps can help hold the pieces square while the glue dries. The fourth piece is the removable cover for this section. Temporarily place it in position to mark the location of the fourth glue block on the wall of the box. Remove the cover and fasten the glue block to the box.

The top of the box has a collar of 1x4 wood that helps lock the two tube sections together. This collar also holds one of four tube baffles. Cut four 12" lengths of 1x4. You can use a simple L or a mitered joint to fasten these. The strips extend about 1¾" into each tube. Glue and screw them inside the top of the mirror box.

Cut three of the four baffles at this point (the fourth baffle is part of the mirror mount) and then install the first one into the mirror box. Make them out of ¼" plywood, two 12" square and one 13" square. Using a saber saw, cut a 10⅜"-diameter circle out of one of the 12" squares, a 10½" circle from the other, and a 11½" circle from the 13" square. A circle guide makes this job easy. Make the cuts with a 15° to 30° bevel; this permits a sharp edge on the baffle to cut stray light rather than diffuse it as a blunt edge would.

Glue the 10⅜" baffle to the mirror side of the 1x4 collar in the mirror box. The sharp edge of the baffle points away from the mirror. Use ¾" wire nails to hold the baffle in place while the glue dries. Nail one side in



KEEPING THE TUBE TOGETHER is the job of four draw catches (the remaining two are out of view, opposite the pair seen). The latch side goes on the upper end of the tube; otherwise the lip on the other part of the catch would collect dirt when the tube rested on the ground during assembly.

place, then use a carpenter's square to check for squareness of the mirror box before nailing the other sides of the baffle. This is the last chance to get this section square, which is needed if the two sections are to fit properly.

Glue and screw three of the four 44" pieces together, using a square to check for 90° angles between the sides. Glue the 11$^1/_2$" baffle to the front of the tube, again checking for square. Hold it in place with $^3/_4$" wire nails. At the other end, attach four 12" lengths of 1x2 as a collar about 2" in from the end of the tube. This collar will hold the 10$^1/_2$" baffle on the mirror-side of the collar and must clear the 1x4 collar on the mirror box. Simple L joints are sufficient. Screw the collar pieces to the tube walls and then glue and nail the baffle to the collar, checking that the tube remains square.

This is a good time to paint the inside of both sections, including the baffles, flat black. Some telescope makers mix sawdust in the paint to provide a rougher surface that is more effective at absorbing stray light. Once the paint dries, attach the fourth wall to the top section with glue and screws. The mirror box requires special fittings to attach its cover: $^1/_4$x20 bolts with an attached knob and right angle fittings designed to hold a bolt in end grain (a metal rod with a $^1/_4$x20 thread tapped along a diameter). Drill four $^5/_{16}$" holes through the mirror box sides and into the glue blocks for these fittings. Drill four $^1/_4$" holes in corresponding places in the cover. Slide the fittings into place, position the cover, and hold it in place with the four bolts.

Slide the two boxes together, perhaps rotating one section until you obtain the best fit. Four draw catches will hold the sections together, two each on opposite sides. Position the catches about 2" from the tube edge, with the strike on the bottom tube.

Finishing Up

Remove the draw catches from the tube sections and round the tube edges with a rasp and sandpaper. Give the tube exterior and the rocker box a final sanding, if you wish, and dust the tube (and workshop) with a vacuum.

Paint the tube exterior and rocker box with a primer. Don't prime or paint the collar that joins the two tube sections. Lightly sand the parts after priming to remove any raised grain.

I painted the tube dark brown so light wouldn't bounce off the tube into a dark-adapted eye looking through the eyepiece. The dark color will also shed heat faster than a light color, a factor important for good seeing. The mount got several coats of almond. It's not as bright as white, but the light color makes it easy to spot the scope in the dark. Use an exterior grade, gloss paint to maintain the scope's good looks after lots of handling.

Once the paint dries, reinstall the draw catches and relax: The main construction jobs are done. In the next issue, we'll tell you how to complete the PortaScope by making a mirror mount, installing the optics, and collimating the mirror. □

ASTRONOMY'S MARKETPLACE

Welcome to the MARKETPLACE section in ASTRONOMY Magazine. These pages are specifically designed to be an affordable and highly effective way for you to market astronomy-related products or services. Call **Debbi Simon** at **800-558-1544, ext. 636** to place your advertising message here.

NEW ZEALAND

6 Nights pristine Dark Sky
observing down-under
each New Moon.

SOUTHERN CROSS TOURS

10 Chapman St. Invercargill New Zealand
Tel. 0116 432 178 717

SEE THE TOTAL SOLAR ECLIPSE !!!

OF OCTOBER 24, 1995
- LIMITED TO 20 PARTICIPANTS -

- ✓ IN INDIA'S RAJASTHAN DESERT
- ✓ BEST VIEWING ON THE ECLIPSE PATH
- ✓ CAMP ON CENTERLINE
- ✓ SEE THE TAJ MAHAL & RIDE AN ELEPHANT
- ✓ OCTOBER 18 - 27, $2,095

Outer Edge Expeditions
(800) 322-5235 · (810) 624-5140
45500 Pontiac Tr· Walled Lk MI· 48390

IDENTI-VIEW™

PREMIUM GLASS SOLAR FILTERS

- HIGH QUALITY
- STRICT CONTROL STANDARDS

CLASS "A"

Color band - blue. Class "A" filters are made *with the same premium quality polished* glass and multi-alloy coating as Class "B". An additional steel alloy added to the coating process makes our Class "A" filters extremely scratch and fade resistant. Excellent for visual and photographic use. Light transmission is 1/1000th of 1%.

CLASS "B"

Color band - white. Class "B" filters are made with polished glass and multi-alloy coating. These filters offer great durability and will provide many years of service and enjoyment with normal use. Can be used visually and for photography. *Light transmission is 1/1000th of 1%.*

CLASS "C"

Color band - red. Class "C" filters are specifically coated to a lighter density (ND-4). They are for photographic use only. This filter is intended for use by professionals and serious hobbyists. Light transmission is 1/100th of 1%.

ORDERING INFORMATION

1. State scope brand and model number, aperture and outside diameter with filter class and price.
2. Make check or money order payable to **J.M.B. Inc.** All foreign checks must be payable through a U.S. bank.
3. Shipped free within the continental United States. All others add $5.50 Shipping and Handling per filter. Michigan residents add 4% sales tax, allow 2-3 weeks for delivery.

For more information see our ad in Observers Guide to Astronomy '95

VISA **J.M.B. INC.** MasterCard
20762 Richard • Trenton, MI 48183
(313) 675-3490 • Fax (313) 285-3015

Shoemaker-Levy Comet Collision with Jupiter CD-ROM

$19.95 + $3 S&H

- Over 350 images,
- Most in color
- 18 animations

For Macintosh & Windows Computers

sdb systems
800 Martin St.
Longmont,
CO 80501

MasterCard/VISA
(303) 440-9140
fax: (303) 651-1964

* *Clear Skies* *

A Newsletter for the Amateur Astronomer

Learn how to choose equipment • Improve your observing skills • Get the most from your telescope or binoculars • Easy-to-understand articles

$19.00 per year • **800-501-3003**
or 10464 Clairemont Mesa Blvd. #222
San Diego, CA 92124

METEORITES

ROBERT A. HAAG METEORITES

All varieties.
Authenticity and
satisfaction guaranteed.

Send $5.00 for a 64 pg, full-color, all-new *Field Guide of Meteorites.* Cost refundable on first order.

To fax: (602) 743-7225
P.O. Box 27527, Tucson, AZ 85726

NIGHTVISION and Binoculars

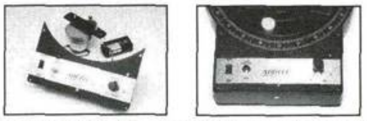
Defy the Darkness ...

Explore the Mysteries of the Universe

Call **INTERTECH**
800-945-9103

RUSSIAN SPACE NEWS

biweekly newsletter, 24-30pp,
$75/yr + air mail (ind), $175/yr (inst.)
Free sample issue 1-800-929-8953 USA,
(216) 962-3400 (non-USA)
P.O. Box 30208, Cleveland, OH 44130, USA
Internet: c@tranquest.com



CONVERT YOUR OLD/NEW CLASSIC 8 TO A C8+

Power your C8 with a single 9 volt transistor battery.
Unit includes: • Precision D.C. Driver and Electronics • Adjustable Speed Control for Solar, Lunar, Stellar & Planetary viewing • 30 - 40 Hours of operation • Low Battery Indicator.

ONLY $124.95 + $5.00 S & H

Optional Remote for Astrophoto: **$144.95**

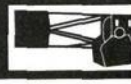
For Information **(203) 925-9250 8 am - 5 pm**
or (203) 924-7181 6 pm - 9 - pm *EST* Mon-Fri

ADDTEC CORP.
P.O. Box 702 • Shelton, CT 06484 – Dept. 21
*Let us **ADD** the **TEC**nical Assistance you need*

Celebrate the Oldest Science

1-800-NITE SKY – Orders Only.
(VISA/MC) or send in check/mo
Complete Brochure: SASE to
Main Sequence, PO Box 3882,
Scottsdale, AZ 85271

M-81 Galaxy (Blk, Cranberry on Ash) M-XL Tee 15.95; L-XL Sweat 24.95. S/H 12%.



NEW! DOB DRIVER II

Dual axis microstep quartz drive fits all Dobsonians, or user-built equatorials. Powerful computerized tracking, panning, and guiding in the palm of your hand! Super portable, super simple, AC/DC/CAR/BAT 12v. Instant setup - NO ALIGNMENT! Multi-function display. Calibration supertunes your scope to maximum performance. Options for PC link/CCD link/field-rot/DSC.

NEW SUPER-SMART SOFTWARE DOUBLES PRECISION!
Control only - $299 ATM System - $399
Complete system w/ready-to-install drives - $499
Free lit - satisfaction guaranteed!

TECH2000 3349 SR99 S
Monroeville, OH 44847
Ph. 419-465-2997 • VISA/MC • WORLDWIDE DEALERS
Pocono Mtn. Optics/PA • Broadhurst-Clarkson-Fuller/UK
Kokusai Kohki/JAP • Ultra-Vue Optics/AUS

Build the Popular Portable Plywood Dobsonian. This portable is easier and less expensive to build and provides better performance. Detaches in 8 pieces.

Video and Amateur Telescope Making Journal reprint — $19.95

JAMES STEWART
314 SOUTH RIVER STREET • FRANKLIN, OH 45005

ASTRONOMY'S
MARKETPLACE

GALAXY COLLIDER 1.0
MSDOS 5.0, min. 386, 486 recommended.
3 coordinate systems, param. files, tilted galaxies, animations, stepping, mouse support. 5.25" or 3.5" disks. $29.95 (U.S. funds), P.M.O. only.
T. Biech, Ph.D.
303-2905 15th Ave.
Prince George, B.C. V2M 1T3 • Canada

Put a comet in your ear!©
The Comet Update Line.
New discoveries. Comet positions from naked eye to magnitude 16.
Positions updated Tues/Fri, 10am MST; discoveries as they happen!
$1.75/min, avg. 3 min. Max. all options $12.25.
Tchtn. ph. req. If under 18, must get parental perm.
Gibeon Designs, P.O. 65863
Tucson, AZ 85728 602-887-2122
1-900-725-4789

Dallas Remote Imaging Group
Astronomy BBS
- Astronomy Databases
- Satellite Imagery Real -time
- Satellite Prediction Programs
- NASA Daily Updates
- Internet Space Newsgroups
- Thousands of Space Images
- Internet Worldwide Access

BBS: (214) 394-7438
Voice: (214) 394-7325
Internet - info@drig.com

MESSIER
MARATHON
OBSERVER'S
GUIDE
Handbook
and Atlas
by Don Machholz

Only $12.00
+ $2.00 Pstg
CA. Res. Add Sales Tax
MakeWood
Products
P.O. Box 1716
Colfax, CA. 95713
(916) 346-8963
VISA/MASTERCARD

WILDERNESS TRAVEL
TOTAL ECLIPSE
October 19–25 1995
- Thar Desert Eclipse Camp in Rajasthan, India
- Highland Eclipse Resort in Thailand
- Angkor Wat in Cambodia

510-548-0420 • 800-368-2794

CENTRAL CAMERA CO.
230 So. Wabash Chicago, IL 60604
1-312-427-5580
1-800-421-1899
(OUTSIDE 312 & 708)
FAX: 1-312-427-1898
WE SELL BOTH
NEW & USED
PHOTO EQUIPMENT
AT **GREAT** LOW PRICES
EVERY DAY! – ***OUR 95th YEAR***
MON-FRI: 8:30-5:30 SAT: 8:30-5:00 (CT)

ATTENTION MEADE LX200 OWNERS!
Now available – Pilot Base Mounting Plate
Enables quicker, safer set-up on tripod. Eliminates difficulty in finding center threaded rod hole and damage to bottom of drive base. Scope cannot slide off during bolt-up procedure. High quality appearance machined from solid aluminum plate. (Patent pending) **$215.00 + shipping**
NMA **New Mexico Astronomical • 505-864-2953**
834 N.Gabaldon Rd. • Belen, NM 87002

Astronomy Start-Up Kit
Includes all the essentials: Star Atlas by Wil Tirion
10" Star Finder • L.E.D. Flashlight • 9x12 Messier Card
400 Page Astronomy Guide by James Muirden
$39.95 + 5.00 SH Visa, Mastercard, Check
Items Available Separately • Other Products Available
Call or Write for Listing **1-800-464-3187**
Chimento Observational, 7354 Sand Hill Rd. Akron, NY 14001

NASA Photo

We've got an easier way to sell your scope

The Starry Messenger astronomy classified shopper is the largest nation-wide listing of the telescopes and accessories currently for sale by amateur astronomers.

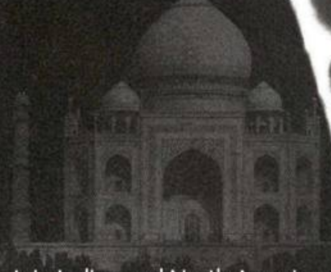
Advertise free - pay a 4% commission when successful
Subscribe - $23 for 12 issues
Save $$$ on used equipment
Over 20,000 sales since 1986
500+ current ads each month

The Starry Messenger PO Box 6552-A Ithaca, NY 14851
(201) 992-6865 FAX (607) 277-0018 CompuServe 75020,3120
MC / VISA / DISC Canada - Mexico please send $29 US funds

Science Connection is a North America-wide
SINGLES NETWORK
through which people interested in science or nature can meet.

For info write: Science Connection, PO Box 188, Youngstown, NY 14174 *or call:* 1-800-667-5179.

INDIA
SOLAR
ECLIPSE
Darkness Sweeps Over
The Subcontinent



Join Indian and North American astronomers for the ultimate eclipse experience, a 15-day expedition through exotic India. View the Eclipse in totality from a superior vantage point southwest of Agra. Journey on one of three itineraries designed to cater to the interests of the cultural, spiritual or natural history enthusiast. Take part in the greatest expedition under the sun, the Solar Eclipse in India.

October 13-27, 1995 $3498
all-inclusive from New York.
Call today for a free color brochure & detailed itineraries.

INTERNATIONAL EXPEDITIONS INC
ONE ENVIRONS PARK
HELENA, ALABAMA 35080
1-800-633-4734

ASTRONOMY'S MARKETPLACE

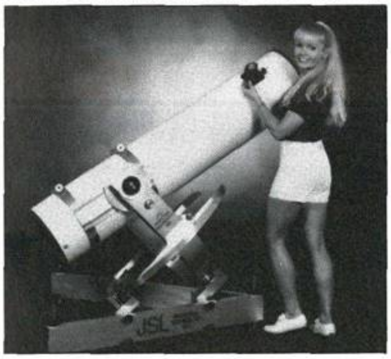
BUSINESS OPPORTUNITY

Earn up to $500 per day doing Astronomy programs with a Starlab portable planetarium!
Initial investment as low as $8950.00.
Call or write for information package and other help starting your own business with Starlab.

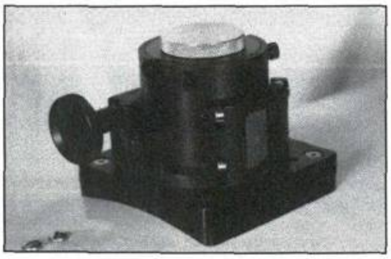
Learning Technologies, Inc.
59 Walden St. • Cambridge, MA 02140
Ph: 800-537-8703 • Fax: 617-547-2686

JSL

INTRODUCES THEIR NEW NEWTONIAN UPGRADE SYSTEM



THE ULTIMATE SOLUTION
FOR RIGIDITY & TRACKING PROBLEMS
ASSOCIATED WITH DOBSONIAN & SHAKY
TRIPOD MOUNTED NEWTONIANS
SHOWN WITH DOBSONIAN TUBE
INTRODUCTORY SPECIAL
$2,195.00
10" & 12-1/2" MODELS
INCLUDES: MOUNT, BATTERY & CHARGER
SPLITRING EQUATORIAL WITH TRACKING
ACCEPTS ALL NEWTONIAN-STYLE TUBES
50 MOUNTS IN STOCK NOW
COMPLETE SCOPES AVAILABLE WITH
PREMIUM NOVA OPTICS
CALL FOR FREE CATALOG
PREMIUM CRAYFORD DESIGN FOCUSER



INTRODUCTORY SPECIAL
$189.00
2" MODEL WITH 1-1/4" ADAPTER
NO EXTRA CHARGE

JSL

P.O. BOX 51, WILLARD, UT 84340
PHONE/FAX: 801/723-5568
SHIPPING AND HANDLING WILL BE ADDED TO ALL ORDERS
VISA & MC ACCEPTED
CASH DISCOUNTS AVAILABLE

SOLAR ECLIPSE TOUR

Presented by
The Alberta Science Centre &
The Royal Astronomical Society of Canada, Calgary Centre.

INDIA – OCTOBER 24, 1995

* *OBSERVATORY VISITS*
* NEPAL EXTENSION AVAILABLE
* ESCORTED TOUR

1-800-667-9986-TEL 1-800-668-9986-FAX
IN CALGARY: (403) 265-8222

LET'S TALK WORLDWIDE TRAVEL LTD.

200, 700 6th AVENUE S.W.
CALGARY, ALBERTA, CANADA
T2P-0T8

YOUNG ASTRONOMERS NEWSLETTER –
For all school ages. Monthly Astronomy and Space news, forecasts, Q&A, *where-to-look* and lots more. A great gift. $11.50/year; (NC residents add 6%).

ARGO
Box 12691B, Winston-Salem, NC 27117-2691

MAKE YOUR OWN TELESCOPE
Mirror grinding & polishing supplies.
Astronomical accessories for building your own telescope. Catalog of supplies & components $2

PALOMAR OPTICAL SUPPLY
P.O. Box 1310 Wildomar, CA 92595
Phone (619) 631-2835
Fax (619) 631-2957 24hrs.

PC

Orders :

Christian Nüesch
Haldenstrasse 12
8320 Fehraltorf

Switzerland

ONLY US$15

USA Dealer wanted

Astronomy - Software

- Fast animated VGA graphics
- Sun, Moon, Planets, Jupitermoons
- Incl. Lunareclipse simulator (EGA)
- High accuary data-tables
- Over 800 sorted city coordinates !

Send $20 bill / check ($15 plus $5 S&H) or just write for more information !

Use IBM Compatible PC / DOS / VGA / Coprocessor supported

made in switzerland

FREE ONLINE ASTRONOMY CLASSIFIEDS

Buy/Sell used scopes, eyepieces, accessories, etc. Post ads immediately. See ads the second they are posted.

The Pegasus Classifieds
Online: 1-303-294-0239 (Data/Modem)
Voice (Denver Tax Software): 1-800-326-6686

AstroSystems
Truss Tube Kits & Components
Including: Primary Mirror Cells, Spiders, Focusers, Sec. Holders, Tube Clamps, Altitude Bearings, Teflon, Ebony Star, Kydex
Free catalog US; foreign $2.00 refunded w/first order
5348 Ocotillo Ct., Johnstown, CO 80534/303 587-5838

FREE LIST OF AVAILABLE SPECIMENS

METEORITES

• New Miles IIE Silicated Iron
• Pallasites and more

Authenticity and Satisfaction Guaranteed
BUY • SELL • TRADE
Southwest Meteorite Lab
P.O. Box 95 • Payson, AZ 85547
FAX 602-474-2474

A-OK! THE WINGS OF MERCURY

The year is 1962...
The place is Cape Canaveral, Florida...
The eyes of thousands turn skyward as a column of flame soars to the heavens...

"All systems are A-OK!"

- An ultra-realistic simulation of America's first manned spacecraft, Project Mercury!
- Based on the original NASA specifications!
- Reproduces *all* switches, gauges & systems!
- Full color, digital sound, including CapCom!
- Actual NASA checklists & flight plans online!
- For the Apple Macintosh!

Call: 1-800-9 SPACE 4 or write.

Do you have the right stuff to fly the **real thing**?

INNOVATIVE TECHNOLOGIES!
156 Seventeenth Avenue
Brick, N.J. 08724-1814

EXPERIENCE THE DEEP SKY!
STARSPLITTER TELESCOPES
HIGH QUALITY ALT-AZ NEWTONIAN TELESCOPES 12.5" - 30". COMPLETE SYSTEMS OR INSTALL YOUR OPTICS
FOR INFORMATION CALL OR WRITE
805-493-2489
3228 RIKKARD DR.
THOUSAND OAKS, CA 91362

LENSES, ACHROMATS & MIRROR BLANKS
TELESCOPE COMPONENTS

★ BUY DIRECT ★ DO IT YOURSELF ★
Stock & Custom unfinished fabricated/molded mirror blanks, diagonals & lenses made from pyrex, optical glasses, fused silica, quartz and other low expansion ceramic materials. Telescope components & scopes. Write, call or fax for free catalog.

NEWPORT GLASS WORKS, LTD.
2044-D PLACENTIA AVENUE
COSTA MESA, CA 92627
(714) 642-9980 FAX: (714) 642-4832

ASTRONOMY'S

MARKETPLACE

Bargain Books

Save up to 80% on publishers' overstocks, remainders. Thousands of books, from yesterday's best sellers to rarely seen titles. **Science and Astronomy,** Photography, History, Biography, Nature—over 40 subject areas. Write for **FREE CATALOG.**

Hamilton Box 15-990, Falls Village, CT 06031

COMPUTER SUPPORTS

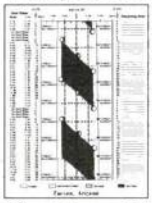
All Telescopes • Notebook $45 ppd

TEKTON INDUSTRIES
1-800-835-8664

1995 +...

Graphic Dark Sky Calendar

Plan your dark sky time at-a-glance.



Uniquely designed 6-page color wall calendar ***customized*** to your latitude & longitude. ***Begins on any month & year.*** Contains rise and set times, note space, & special graphical features.

Send for laminated 'vacation' calendar. Any location! ($3.00 for 1 month, $4.50 for 2 months. Add $1 shipping.)

Complete year, 11"x17", spiral-bound: $14.95

Add $2 shipping, ck/m.o.

Enclose custom name and location with order.

Gibeon Designs P.O. Box 65863, Tucson, AZ 85728
602/887-2122 (eve's MST, M-F)
E-mail: **#74721.3007@compuserve.com**

SCIENCE SOURCE

STOCK PHOTOGRAPHY AGENCY specializing in science, astronomy, space and Earth images would like to review portfolios of *talented* ***Illustrators and photographers*** for possible representation.

A Division of Photo Researchers

CALL Steve Gerard 1-800-833-9033

PIXFIX

Image Processing Software

For ST-4, PC-LYNXX, ELECTRIM and Cookbook-211 cameras.

Blazingly fast operation. You've got to try it to believe it! Over 70 options, including: Scaling • Masking • Merging • Filtering • Dodge/Burn • Cut/Paste • Optimize • Equalize • Zoom • Shrink • Co-Add, & too many more to mention.

Store up to four images in memory at a time.

Includes Illustrated manual for the beginner or advanced CCD imager, 15 images, and FREE slideshow program.

Minimum Requirements: DOS 3.1, XT or compatible System, and VGA Monitor.

60 day no-questions-asked 100% satisfaction guarantee!!

Introductory price: $29.95 + $3.00 S&H
(MI. residents include 6% Sales tax).
Specify diskette size when ordering. Send check or money order to:

Bruce Johnston Computing
7764 Tull Ct. Waterford, MI. 48327
1-810-666-2186

Space Calendar for 1995

ASTRONOMY & SPACE
1995 WEEKLY CALENDAR

Visit a new celestial destination **every week** while you organize your life on Earth.

This 120-page engagement calendar features **54 full-color images** from the NASA archives, major observatories, planetary spacecraft, the Hubble Telescope and more! 6"x9", sprial bound.

$12.95 for first calendar.
Additional calendars **$9.95** each.
Free shipping in US & Canada.
Overseas add $5 for airmail.
Visa, MC, check, US funds.

Starry Messenger Press
PO Box 6422-A
Ithaca, NY 14851
(800) 736-6836
(607) 277-0018 FAX

Order risk-free: Money-back if not completely satisfied.

YOUR HOME COMPUTER
WILL COMMAND THE 18 AND 25 INCH TELESCOPES AT
OUR MOUNTAINTOP OBSERVATORY.
VIEW, TAKE PICTURES AND SAVE THEM FROM HOME.
THE JOHNSTON'S REMOTE ASTRONOMY CENTER
WILL HAVE *CRYSTAL CLEAR VIEWING....LONG DISTANCE.*
ORDER PROJECT INFORMATION PACK TODAY
JUST $ 8.00 + 2.00 S & H FROM: JAMES JOHNSTON
PO BOX 91417 ; PORTLAND, OR ; 97291-0417

OASIS GROUP PRODUCTIONS

GLOW in the dark full moon T-SHIRTS

$19.95

INCLUDES SHIPPING & HANDLING

QUALITY SCREENPRINTING

1-800-PALM-TEES

CUSTOM & GROUP RATES AVAILABLE

IOWA SCIENTIFIC OPTICAL

Newtonian Primary Mirrors
Figured to λ/8 surface error (PV.)

6"	(F/4-10)	**$145**	10"	(F/6-10)	**$405**
8"	(F/5-10)	**$210**	12.5"	(F/6-10)	**$595**

Super-Planetary Newtonian Mirrors
Figured to λ/16 surface error (PV.)

6"	(F/10-15)	**$170**	10"	(F/10-15)	**$450**
8"	(F/10-15)	**$250**	12.5"	(F/10-15)	**$650**

Schiefspiegler Optical Sets
Includes Primary and Secondary figured to λ/16 surface error (PV.)

4.25"	F/26	**$305**	5"	F/28	**$365**	6"	F/30	**$425**

Also:
Elliptical Flats; Spiders and Secondary Holders; Equatorial Mounts; Tube Assemblies and Complete Telescopes.

4231 Northwest Drive
Des Moines, Iowa 50310
Ph. (515) 255-0166

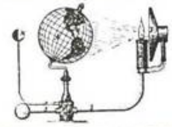
METEORITES!

Irons. Stones. Stony-irons. Tektites.
Quality display and study specimens.
Space jewelry, books, slides.
Authenticity guaranteed.
Color Catalog $2.

CATCH A FALLING STAR!

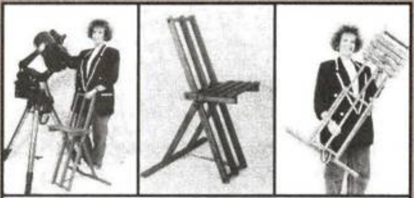
Bethany Sciences
P.O. Box 3726-A
New Haven, CT 06525
(203)393-3395

The very *RARE* – and LONG-LOST–*Patent Drawings* of THE **19th Century** *MECHANICAL MODELS of the SOLAR SYSTEM:*



Matted and **Framed – Beautiful!**

For *FREE* brochure
Call *1-800-472-3843*



Observer's Chair

- ☆ Hand Crafted - Solid Oak
- ☆ Easy storage - Lightweight (under 10 lbs.)
- ☆ 36" Tall - Adjustable seat moves 18" to 36" (Max. Weight is 250 lbs.)

$69.95 (Plus $10 shipping in the U.S.)

K.C. Woodsmith P.O. Box 75033
Wichita, KS 67275-0033 Phone: (316) 721-1566

Buy a Star ★ Name a Star

On the exclusive MSAS Star Atlas
to be placed in our future observatory & science center.

Starting at only $30.00!

Receive a certificate of record and more.

Free brochure.

(909) 336-1699

Mtn. Skies Astronomical Society
Box 1169 - Lake Arrowhead, CA. 92352

VISA/MC accepted

NEW HANDY POWER SYSTEM™

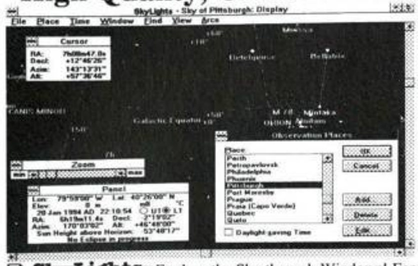
Dual 12v Outlets • 12v Rechargeable
Multi D.C. Voltage • 3-6-9-12-volt Output
Up to 12 Hours Of Use With Each Charge
Very Compact • Weighs Only 6 lbs.

Only $49.95 + $6 U.S. Shipping

Rex's Astro Stuff • 63 Observatory Ln.
Dover, AR 72837 • (501) 331-3773

Astronomy Software

High Quality, Great Prices!


SkyLights - Sky of Pittsburgh: Display
File Place Time Window Find View Area
Cursor
Zoom
Panel
Observation Places
OK
Cancel
Add
Delete
Edit
Daylight saving Time

☐ **SkyLights**™ Explore the Sky through Windows! For any date from 4700BC to 9999AD see Sun, Moon, planets and stars, plus all Messier objects and hundreds of selected NGC and IC objects (galaxies, clusters, etc.). Skylights is very easy to use and takes full advantage of the Windows environment, such as printer support and moveable information windows. Track an object across the sky using time steps you specify. Get detailed information by clicking on an object, such as RA & Dec., Alt & Azm, geo & heliocentric Lat & Long, rise and set & more. Database of world cities lets you pick any observing site, add your own. Database of sky events like eclipses, occultations, etc. is included, just click and observe. Has three information windows you can toggle on or off. Zoom in or out. Many controls to customize program the way you like! IBM, Windows 3.1 **$89.95**

☐ **Ceres**™ Calculates ephemeris & plots sky path for all asteroids or minor planets. Almost 6,000 included in database, with names & #'s, orbital elements, magnitudes, etc. Developed by world's authority for minor planets, the Institute of Theoretical Astronomy of the Russian Academy of Sciences. Plots asteroids against the sky using 200,000 reference stars. See orbits plotted around the Sun. IBM EGA/VGA, harddrive, 7 meg. **$159.95**

☐ **Satellite Pro**™ - Earth satellite tracking for high accuracy ephemeris & simultaneous propagations & for optical & radio tracking. Flies up to 200 satellites simultaneously. Comes with nearly 4,000 satellite orbital element sets; info for free updates. Displays Earth ground tracks, sky maps with stars, planets, Sun, Moon. Satellite RA/Dec, slant range, range rate, intersatellite range, phase angles, height, altitude & sky velocities, AOS time & pass duration. IBM VGA, harddrive **$149.95**

☐ **AstroCalc Super**™ Input time, date & lat./long. & get for Sun, Moon & planets: Right Asc./Dec., Alt/Azm, Ecliptic Lat./Long., Angular size, Fraction Illum., Elongation, Rise/Set Times, Distances from Sun & Earth, Sidereal Time, Twilight Times, Helio and Geocentric Data. Automatic repetitive calculations(solar/planetary positions or any other data for every hour or day, etc.). Output as ASCII text file or to printer. Plots of Sun, Moon & Planets on screen or laser/dot matrix printers. Helio & geocentric plots of longitude & distance or latitude & distance, RA & Dec. or altitude & azm. IBM EGA/VGA **$89.95**

☐ **AstroCalc for Windows**™ Functions similar to Super version but uses MS Windows interface. IBM **$99.95**

☐ **Gravitator Pro**™ Calculates gravitational forces on bodies like stars and planets & determines orbits. See paths plotted, vary scale of view & orientation, use 3D option. Input initial conditions or use examples provided. Save systems to run later. Display distances between bodies & forces between pairs of bodies, more! Print to dot or laser. IBM EGA/VGA, **$129.95**

☐ **StarPilot**™ Pilot your own personal starship through the universe! Explore our own real Solar System & its planets & satellites as well as 6 imaginary star systems with planets, some inhabited. Hundreds of different bodies and over 50 space stations & ground bases give you a long term high adventure! Accurate visual & flight dynamics of spaceflight developed by Ph.D. astronautical engineer. Head out to the Moon, orbit Saturn, land on Mars or go far beyond! IBM EGA/VGA **$59.95**

☐ **SunTracker Super**™ Plots solar eclipses on variable scale world maps, plus numerical data. Specify center of map & size by giving lat. & long. limits. Central line of totality is plotted & lines for north/south limits of visibility. Country boundaries & major rivers plotted. Cities can be added to maps. Output to screen or printer. IBM EGA/VGA, harddrive **$89.95**

☐ **SunTimes**™ Monthly or yearly sunrise & sunset tables for any year and location. Output to screen or printer. Twilight times, maximum altitude of Sun, azimuth of rise/set. IBM **$29.95**

☐ **MoonTimes**™ Similar to SunTimes but for the Moon. Includes rise/set times, phase & azimuth at rise/set. IBM **$29.95**

MasterCard **Order Today!** VISA

☎ 1-800-533-6666

24 Hrs, 7 Days - FAX Orders to 412-422-9930
For Info or in PA Call 412-422-6600

Order by phone, FAX or mail. Check, M.O., or credit card (give # & exp. date). Add $4 shipping($6 outside US). In PA add 6%. Give disk size, $1 extra for 3.5". Join thousands of satisfied customers in over 120 countries. Fast shipment, friendly service.

Zephyr Services

The Leading Astronomy Software Publisher

ZS
1900 Murray Ave. Dept. B
Pittsburgh PA 15217
FREE Catalog, Call or Write
Our 14th Year

NEW PRODUCTS

Improved CG-11 Telescope Package

Celestron's 11-inch Schmidt-Cassegrain telescope is available on a redesigned Losmandy mount. The German equatorial mount has adjustable tripod legs, bigger right ascension and declination shaft bearings, and an extended declination axle that provides more room for counterweights. The CG-11 comes with a 26mm Plossl eyepiece, 7x50 finder, star diagonal, 12-inch power cord that plugs into a cigarette lighter, telescope hand controller, and a carrying case with a redesigned interior. The electronics run on 12 volts DC power and have a built-in transformer to operate on AC.

Celestron, 2835 Columbia Street, Torrance, CA 90503, (310) 328-9560, fax (310) 212-5835. Model #11054 (telescope and mount): $6,198.

Flashlight, Tripod Tray Illuminator, and Power Center

The StarBrite-NiteLite red LED flashlight (left) is less than four inches long and weighs only a few ounces. It comes with two AA batteries and a krypton bulb. To light an accessory tray, the Tripod Tray Illuminator (right) attaches to the underside of any mount or tripod with a hook and loop fastener. Its red LED's intensity is adjustable and runs on an internal 9-volt battery or external 12-volt DC power source. When the illuminator is plugged into external power, the internal battery is automatically bypassed. The Power Distribution Center (top) accommodates up to three electronic accessories on one 12 VDC line. Accessories plug into 5.5/2.1 mm power jacks. All products come with a limited lifetime warranty.

POWER DISTRIBUTION CENTER
12vdc input/12vdc output
R. E. ADAMS ELECTRONICS
StarBrite-NiteLite
12VDC INPUT

R. E. Adams Electronics, 1361 Tierra Bonita Place, Chula Vista, CA 91910-7125, (619) 421-6547. StarBrite-NiteLite flashlight: $12.95 plus $1.50 shipping and handling; Tripod Tray Illuminator: $15.95 plus $3.50 S&H; Power Distribution Center: $16.95 plus $3.50 S&H.

Long Eye-relief, Waterproof Binoculars

Eterna binoculars offered by Brunton Company are rubber armored and waterproof and come with a lifetime warranty. The 7x42 and 8x40 models have an eye relief of 22 mm, while the 10x50 binocular (standing) has an eye relief of 21 mm. All three models have roll-down eyecups for use by eyeglass wearers. The optics are multicoated to reduce glare and sealed in the binocular housing with nitrogen gas. Models come with a cordura carrying case, lens cleaning solution, and a large cleaning cloth.

The Brunton Company, 620 East Monroe, Riverton, WY 82501, (800) 443-4871, fax (307) 856-1840. 7x42 (model 4002): $349; 8x40 (model 4004): $359; 10x50 (model 4003): $369.

At Roger W. Tuthill, Inc.,
We Don't Just RESHIP Meade and Celestron Scopes as Others Do,
We Test Them Individually.

Our Experience of 21 Years Lets Us Apply a "Personal Touch", Inspecting & Improving the Telescopes We Sell. Our Line of Accessories Makes Them Easier to Use and Gives You Less Hassle. Why Gamble With a Big Volume, Impersonal, Quick-Sale-Mail-Order Company?
For Answers or Advice, Call TOLL FREE 1-800-223-1063 and Talk to **Astronomers, NOT Clerks.**

Tuthill Accessories

WE NOW OFFER "TWO-TIER PRICING" – A NEW CONCEPT

Send a 9" x 12" S.A.S.E. with 4 stamps for complete catalog. Includes prices and description of **DELUXE CERTIFIED SCOPE PACKAGES** for Meade 4", 8", 10", & 12" Schmidt-Cassegrains, Celestron C5, C8+, Ultima® 8-PEC, Ultima® 2000, Questar, and Odyssey.

Example DELUXE CERTIFIED SCOPE PACKAGE

Celestron's ULTIMA® 8-PEC with large wedge, adjustable height tripod, all standard accessories....$2045 Includes:

- Free Deluxe Accessory Case, Lens Shade, and Piggyback Mount.
- Free set of Tuthill Astro-video Instruction tapes.
- 25% off Tuthill accessories when purchased with scope.
- Tuthill Inspection, Guarantee and After-Purchase Support

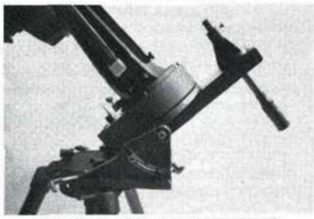
Visit our showroom. We sell binoculars, astronomy books, Lumicon filters, JMI products, software, and pre-owned equipment.

We clean and repair telescopes.

The very portable 8" C8+ on Isostatic Equatorial Mount from $1495.

Heatable NO DU CAPS for SCTs and Refractors

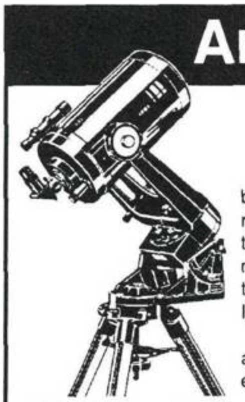
80mm Erect Image ULTIMATE FINDER includes bracket and 21mm ocular.


PRECISION POLAR AXIS FINDER® for EXACT polar alignment in minutes.

Roger W. Tuthill, Inc.
11 Tanglewood Lane, Dept. A • Mountainside, NJ 07092 • Phone 908-232-1786 • FAX 908-232-3804
VISA, MC, COD, Personal Checks, Time Payment Plans

Anybody can sell you a telescope.
We'll sell you the right one.

Authorized Meade Dealer



Hardly a day goes by that we don't get a letter like the one below, or a call that goes something like this: "Your ads are right. So and so on the East Coast advertises low prices – but they don't have anything in stock, they couldn't answer *any* of my questions, and they wanted my credit card number before they'd even *talk* to me. They said if I wanted to ask questions, I should call the manufacturer . . . and then they hung up on me!"

It takes more than a camera store clerk with a price list and a bad attitude to help you pick the right scope. It takes experience. It takes people who actually use the scopes and accessories they sell. At ***astronomics***, we have that experience. We've been selling telescopes for 16 years. Some of us have been using them far longer than that. From $329 to $16,000, we'll help you pick the telescope and accessories that fit your needs . . . *and your budget.* Meade, Celestron, TeleVue, Edmund, Questar, and more – we have *all* the good stuff.

astronomics. No hard sell. No guesswork. Just honest advice, the *right* telescope . . . and a good price.

Call us at (405) 364-4898 and find out for yourself. Our years of experience are yours for free.

We have Meade Advanced Products – scopes and accessories – *in stock!*

Whether it's a Meade telescope, like the basic 2080B shown above or the latest fully computerized LX-200, or a simple Meade accessory like an eyepiece, a filter, a Barlow, or a camera adapter – if Meade makes it, chances are good we have it in stock. Since Meade prices are about the same anywhere you call (although one of our customers told us another dealer advertised a 10" LX200 for $2895, but charged his credit card $3300 for it – *and never shipped the scope)*, there's no sense in buying from a dealer who takes your money and makes you wait and wait – not when you can get it *now* . . . from ***astronomics.***

Want to pick the right telescope? Our free catalog tells you how!

Call us at (405) 364-0858 for your *free* copy of our catalog 95AST covering the hundreds of scopes and accessories we stock – from Meade, Celestron, Edmund, Questar, TeleVue, Lumicon, JMI, SBIG, and more. We'll include our 8-page guide on how to pick the right telescope and your discount prices on everything we carry. It's yours for only the cost of a one minute phone call.

> I am sure you get hundreds of statements like this but please let me reiterate. I have received nothing but courteous and professional behavior from your phone order service. You were very knowledgeable and answered all my questions totally. As a result, I will exclusively use your company to order all my accessories. I will also recommend you to all my colleagues in the Physics and Astronomy Department. Once again, Thank you very much. I look forward to doing business with you in the future.
>
> **Customer Quote of the Month #34**

astronomics *Our 16th year of friendly service, good advice, and money-saving prices.*

2401 Tee Circle, Suites 105/106, Norman, OK 73069
Order Line: **(800) 422-7876** 24-hour Fax: **(405) 447-3337** Catalogs/Advice: **(405) 364-0858**
Hours: Monday thru Friday, 10:00 AM to 5:00 PM CST U.S. SALES ONLY Mastercard, Visa, Discover, American Express $5 minimum freight

A CLASSIC RETURNS

Enjoy the quality of a hand crafted scope by Steve Dodson for only $189.00

- Carry it out in one hand...

Sharp wide-field sky views are only moments away.

Total weight only 7lbs.

- Exceptionally smooth steady wood mount and tripod
- 1 1/4-inch standard eyepiece gives 42 power

(substitute other standard eyepieces to get up to 125 power)

- Easy-aim "gun sight" finder

Sgr-3
Reflecting Telescope

Write: Stargazer Steve, 1752 Rutherglen Cres., Sudbury, Ontario P3A 2K3, Canada Phone: (705) 566-1314

Where the Earth & Sky meet. Every day.

Earth & Sky, the fun, informative, 2-minute daily astronomy and Earth science radio series can now be heard on more than 500 commercial and public radio stations, in all 50 states and abroad. Hosted by Deborah Byrd – a regular columnist for *Astronomy* magazine – and Joel Block, **Earth & Sky** answers your science questions.

Earth & Sky, made possible by a grant from the National Science Foundation, **is FREE** to all radio stations.

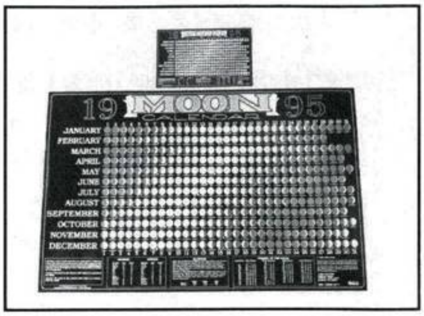
For more information, contact your local radio station or call **Earth & Sky** at (512) 480-8773.

Earth & Sky

BYRD & BLOCK COMMUNICATIONS, INC.
P.O. BOX 2203, AUSTIN TX 78768–2203
(512) 477–4441 FAX (512) 477–4474

Illus: © Matt Lynaugh 1994

PRODUCTS



Lunar Phase Calendar for 1995

This calendar graphically portrays lunar phases for each day in 1995. A box indicates times when the Moon is at perigee (closest to Earth) and apogee (farthest). Other boxes provide eclipse information and times when the Moon is at First Quarter, Full, Last Quarter, and New. The calendar comes in two forms: a $31\frac{1}{2}$" x $20\frac{1}{2}$" poster printed on glossy stock and $6\frac{1}{2}$" x $10\frac{1}{4}$" cards printed on card stock. The poster version is shipped rolled in a mailing tube; cards are available only in lots of ten.

Johnson Books, 1880 South 57th Court, Boulder, CO 80301, (303) 443-1576, fax: (303) 443-1679. Poster: $9.95; cards: $20 for ten; add $3 per order for shipping and handling.

HORSEHEAD NEBULA

Astronomical Tees

New T-shirts by Main Sequence astronomical apparel feature the Horsehead Nebula and the spiral galaxy M81. The Horsehead Nebula is portrayed in fluorescent red, purple, and white on a black background. M81 is printed on an ash T-shirt in black puff ink with "M-81 Spiral Galaxy" labeled in cranberry. Both shirts are made from preshrunk, heavyweight, 100-percent cotton, and come in sizes from medium to XX-large. Other designs feature the scientist Galileo, the Trifid Nebula, and a collage of 18th-century telescopes.

Main Sequence, P. O. Box 3882, Scottsdale, AZ 85271, (800) NITE SKY. $15.95; wholesale pricing available.

Season's Greetings from POCONO MOUNTAIN OPTICS

For All Your Astronomical Needs

Tele Vue "When You Want The Finest"

We stock the entire TeleVue line for shipment in time for Christmas. — All items also on display and available for purchase and pick up at our showroom.

NEW for 1994

Panoptic 15MM and 27MM Eyepieces In Stock — Tack Sharp 68° Apparent Field!

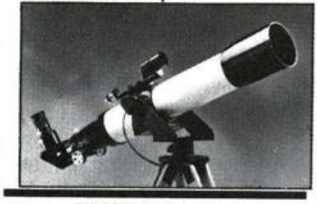
SPECIAL — We've just uncovered in our inventory a supply of discontinued 24MM Widefield eyepieces. Hurry and get yours while they last. Special Price $155.

All Eyepieces and Accessories at Holiday Sale Prices

Plossls! 7.4, 10.5, 13, 17, 21, 26, 32, 40, 55MM
Widefields: 15, 19, 24, 32, 40MM
Naglers: 4.8, 7, 9, 12, 13, 16, 20MM
Panoptics: 22, 35MM
Barlows: 1.25″, 1.8x, 2.5x 2″ 2x Barlow
Paracor: Eats coma in Fast Dobs. 1¼ & 2″ sizes

Pronto 70MM AP. F6.8, 480MM F.L. Available in 1¼″ Image Erect, 1¼″ Star Diagonal and 2″ Star Diagonal models.

"The little scope — that could"



Sky Tour has arrived! Exciting Sale Priced Packages for Genesis and Gibraltar — contact us for exciting details which include Free Eyepieces, Solar Filter and More!!

BINOCULAR SPECIALS

Fujinon FMT SERIES

Ideal for Astronomy

6x30 FMTR-SX	$348.
10x70 FMT-SX	$479.
7x50 FMT-SX	$398.
16x70 FMT-SX	$540.
7x50 FMTR-SX	$459.
Tripod Adptr.	$15.
8x40 BFL Close Focus w/lock	$229.

We also carry and stock Zeiss, Swarovski, Swift, Nikon, Aus Jena, Pentax, B&L, Steiner, Minolta and Kowa spotting scopes.

SPECIAL PURCHASE

10x30 Adlerblick	$109.

JIM'S MOBILE

We stock the entire JMI line - Call us and save.

Moto-Focus LX3/5/6/200	**$79.00**
Moto-Decs LX3/5/6	**$75.00**

Moto-Focus and Moto-Decs for all scopes avail. Contact us for special sale prices on NGC Mini Max, NGC Max, Micro Max.

New — NFG-2 Deluxe Focuser (used on NGTs) with or without motor focus.

SPECIAL - Eliminate Image Shift with NGF-S Focuser **$269.00**

STOCKING STUFFERS

T-Rings (spec. camera make)	$10.00
Tele-Extenders & T-Adapters for SCT's	$22.00
Color & Moon Filters 1.25	$12.00
(Set of 6) Color & Moon Filters 1.25	$59.95
Drives for Tasco Eq. Mount	$75.00
Anti-Vibration pads for Tripods	$40.00
Tripod Slo-mo controls	$36.00
New Deluxe Optics Cleaning Kit	$19.00
Celest. F6.3 Reducer/corrector	$118.00
Celest. Photo Deluxe Tripod	$95.00
12 Volt Dew Remover Blower	$11.95
Kwik Focus-Lens Cap 8″	$39.95
Kwik Focus-Lens Cap 10″ & 11″	$44.95
Red LED Chartmaster flashlight	$17.50

THOUSAND OAKS SOLAR FILTERS

— The Best —

See actual sunspots safely with your telescope

Type I 8″	$88.00	Type II 8″	$115.00
Type I 10″	$98.00	Type II 10″	$128.00

ALL sizes available for all scopes.
Type III and new thread ins avail.

NEW SOLAR PROMINENCE FILTERS

See solar prominences with your refractor or Cassegrain with new Thousand Oaks Optics Solar Prominence Packages. Contact us for introductory specials.

ALL LUMICON FILTERS IN STOCK

We carry D&G Refractors;
Tech 2000 Dob Drives
We are an authorized Parks Dealer.
Contact us for Daystar-T-Scanners
University Optics Dealer

NEW — VIEWING CHAIR $149.00

NEW LOSMANDY GM-8 with Polar Finder and Dual PEC Drive, ideal for refractors and 8″SCT's. $1349.00

A Pocono Mt. Optics Exclusive

We Are An Authorized Losmandy Dealer

SPECTRA ACCESSORIES SOLVE FOCUS PROBLEMS FOREVER

with Spectra's Sure-Sharp Optical Grid Focusing method for perfectly focused astrophotos

Sure-Sharp	$135.00
Point Source	$59.00
Rt. Angle viewer	$49.00
Duo-View	$79.00

Spectra Guide/Deluxe Radial Model — Call

Desert Storm Covers in

Protect your investment — Covers avail. for all size scopes

CCD Cameras have arrived!

EDMUND SCIENTIFIC

Astro Scan 2001 World Famous 4¼″ Portable Reflector Scope $298.00

ASTRO SCAN ACCESSORIES

New Tripod for Astro Scan	**$87.00**
Tripod Bkt ...... $41.95 Tote Bag	**$29.95**
Var. Cam. Ad	**$67.95**
Sun Viewing Screen	**$45.95**
St. Thru Image Erector	**$59.00**

EYEPIECES & ACCESSORIES

1¼″ RKE 8, 12, 15, 21 or 28MM	**$41.95**
RKE 2.5x Barlow	**$64.95**

Edmund, Orthos, Kellners, Ortho ZOOM Sale priced.

ALL EDMUND PRODUCTS AVAILABLE

Tectron Collimators improve Newtonian images w/the following:

Sight Tube	$29.00
Cheshire Eyep.	$38.00
Auto-collimator	$31.00
Above 3 w/Bklt.	$95.00
New "Revised" Booklet on Collimation	$6.00

For that Fast New Scope You're building or for upgrading your current scope —

New — The Modern Dobsonian Booklet	$11.00
Ultra Low Rack & Pinion Focuser 2″ w/1¼″ Adptr.	**$125.00**
Photographic Focuser	$159.00

QUARTZ DRIVE CORRECTORS BY VOGEL — All Digitrak II

SINGLE AXIS

VE-200 Runs off DC	$132.95
VE-300 Runs off DC/AC	$159.95
VE-400 Runs off DC/AC or Int. Battery	$198.95

DUAL AXIS

VE-200 D	$174.95
VE-300 D	$212.95
VE-400 D	$262.95
VE-100 Inverter (converts your motor to DC)	$71.95
Interface Cable for SBIG-4	$17.95

NEW VE MINI TRAK

VE MINITRAK

State-of-the-art, variable speed drive corrector, power inverter. Includes digital quartz tracking indicator — Easily hand held. Complete with D.C. cord. Sale Price $84.95

Now Available The Kendrick Dew Remover System

For all size scopes, finders, mirrors

COMPUTER SOFTWARE

Dance of the Planets with companion Sale Price $125

Dance of the Planets with companion and extensions Sale Price $155

"THE SKY"

Levels 2 & 3 avail. DOS or WINDOWS. Computer/scope interface kits in stock - CD ROM Level 3 and GSC avail.

SkyPro software now available.

STARGAZE	$79.00
New RED SHIFT CD ROM for Windows & Mac	$55.00

TELRAD w/Base

$39.00

Batteries included!

Hinged Deluxe Dew Caps	**$10.00**
Extra Bases	**$7.95**
Extra Reticles	**$2.95**
Pulsar Unit	**$19.95**

CELESTRON

New Celestron Ultima 2000 8″ and SCT's have arrived. Contact us for details.

We carry the full line of Meade telescopes and accessories.

New Flexible Dew Shields

8″ – $29.00 10″ – $39.00

Questar

We are a stocking, authorized Questar Dealer. Please contact us for sale prices before you purchase!

SPECIAL PURCHASE — 3.5″ STD, Pyrex w./mag. fluoride and power guide. Factory sealed — Call!

Astro Systems

We carry Astro Systems full line of telescope making equipment, Primary Mirror Cells, Secondary Holders, Heavy-Duty Spiders, Teflon Bearing Kits.

Announcing Enhanced Coated Secondary Mirrors — Intro. Prices

1.3″ — $38 1.5″ — $42 1.8″ — $48
2.1″ — $58 2.6″ — $68 3.1″ — $99
3.5″ — $199 4.0″ — $249

12 AMP HR. Heavy Duty PORTA-PAC $86.95

PORTA-PAC $65.00

BEATTIE INTENSCREEN-PLUS

Ultra bright focus screens for:

Olympus OM-1, 2, 3, 4	$62.00
Nikon F, F2, F3	$93.95
Nikon FE, FE2, FM2, FA	$62.00

EYEPIECE SPECIALS!!

Buy Direct and Save

Coated and threaded for filters:

1¼″ Kellners 6, 9, 12, 18, 25MM	$29.95
1¼″ Orthos 4, 5MM	$46.95
1¼″ Orthos 6, 7, 9, 12.5, 18, 25MM	$44.95

1¼″ ERFLES

16.MM	$58.00	25.MM	$62.00
20.MM	$60.00	32.MM	$70.00
2″ Erfle 32MM	**$125**	1¼″ 2x Barlow	$39.00
1¼″ 8.4-21 ZOOM			$85.00

Vixen LV Eyepieces in stock from $94.00

BOOKS & STAR CHARTS

MAG 5 Star Atlas ...... $6.50 MAG 6 Star Atlas	$16.95
Sky Atlas 2000 Field or Desk	$19.95
Sky Atlas 2000 Color	$40.00
NEW Sky Atlas Companion	$24.95
Laminated Deluxe 2000 Color	$84.95
Laminated 2000 Field or Desk	$58.95
Burnham's Handbook — All 3 Volumes	$35.95
Norton's Sky Atlas	$38.95
Uranometria Vol. I or II	$39.95
Astrophotography for the Amateur	$18.00
Astrophotography by Gordon	$18.00
Astrophotography II by Martinez	$18.00
Backyard Astronomers Guide	$39.00
Atlas of the Moon by Rukl	$27.95
Deep Sky Field Guide to Uranometria	$49.95
All About Telescopes by Edmund Scientific	$13.95
How to Choose Binoculars by A. Hale	$5.00
1000 +	$33.00
Atlas of Deep Sky Splendors	$39.00
New CCD Cookbook	$28.00

POCONO MOUNTAIN OPTICS — North Pocono Village Shopping Center
RR 6, Box 6329, Moscow, PA 18444

Catalog: $6.00 (within U.S.)
$9.00 to Canada
$15.00 Elsewhere

No surcharge on credit cards

Showroom Hours, 10 am-5 pm Monday thru Saturday
We purchase and take in trade used telescopes

$5.00 MINIMUM SHIPPING — U.P.S. (IN U.S.)
Speak with amateur astronomers . . . ASK FOR GLENN — ARS: K3WEI, DON KD3LN or MIKE

P. List send SASE w/58¢ in stamps

ORDERS - TOLL FREE — 800-569-4323 till 9 P.M. 7 days a week (info) **717-842-1500** till 9 P.M. FAX (24 hours) **717-842-1408** **WORLDWIDE SHIPPING**

NEW! Astronomy: Through Space and Time
by Sune Engelbrektson
American Museum–Hayden Planetarium, and
Pace University Westchester
1994 • full-color • 464 pages • paperback
ISBN 0-697-10923-2 • $50.00 plus shipping

WCB Wm. C. Brown Publishers
A Division of Wm. C. Brown Communications, Inc.
2460 Kerper Blvd., Dubuque, Iowa 52001

✆ 1-800-338-5578 to order or
receive an exam copy

Explore the Universe without leaving the house!

Exploring the Universe 1995 Calendar
From the editors of ASTRONOMY magazine
Take a year-long tour of the finest sights in the universe. Breathtaking photos and artwork include Comet West, a geyser erupting on Neptune's moon Triton, the Galileo spacecraft's encounter with Io, the Pleiades star cluster, and more. Each month also includes helpful information on when to view meteor showers, eclipses, the planets, hases of the Moon, and other celestial events. 14 x 11, 13 color photos.
#68079 ....$10.95

EXPLORING THE UNIVERSE 1995

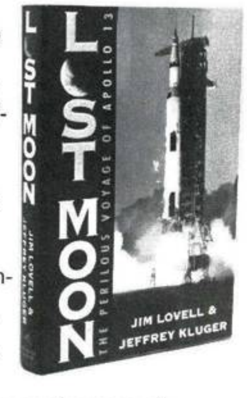
To order, call toll free
1-800-533-6644, 24 hours a day.
For faster service call Monday – Friday 8:30 am – 5:00 pm CT.
Please have your credit card ready. Fax 414-796-0126.
Outside the U.S. and Canada call 414-796-8776.

Or use the enclosed order form and send your order to Kalmbach Publishing Co., Dept. AL015, 21027 Crossroads Circle, P.O. Box 986, Waukesha, WI 53187-0986. Include for postage and handling: U.S. add $3.00 for 4th class (or $4.50 UPS in the continental U.S. only), Canada add $5.00, other foreign add $10.00. Maryland and Wisconsin residents add 5% sales tax to total. Virginia residents add 4.5% sales tax to total. Canadian orders add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

Dept. AL015

ASTRO BOOKS

Apollo 13: Terror and Triumph



ASTRONOMY: Jim Forbes

Lost Moon: The Perilous Voyage of Apollo 13
Jim Lovell and Jeffrey Kluger, (Houghton Mifflin Company, 1994), ISBN 0-395-67029-2, 366 pages, hardcover, $22.95.

Apollo 11 was remembered last summer for its momentous achievement of landing the first man on the Moon. This spring marks the silver anniversary of another Apollo mission that left the world equally breathless: Apollo 13. For four days in April 1970, the entire world watched as NASA engineers struggled to keep three astronauts alive (Jim Lovell, Jack Swigert, and Fred Haise) after an oxygen tank explosion destroyed their spacecraft's electrical and life support systems. Forced to shut down the command module, the crew took refuge in a lunar module intended to support only two people for two days. It had to keep three men alive for four days.

In *Lost Moon*, Apollo 13 commander Jim Lovell teams up with writer Jeffrey Kluger for a moment-by-moment account of the mission as seen through the eyes its crew, their families, and flight controllers. If anything contributed to NASA's can-do Apollo image, it was the agency's ability to pull off saving the astronauts' lives. Many outsiders gave the crew only a 1-in-10 chance of survival. Every minute of time, every watt of electricity, each cubic liter of air, was borrowed, eked, or cajoled from other systems on the spacecraft.

The challenge was absolutely daunting and terrifying. When the severity of the explosion finally sank into the minds of ground controllers (for a few minutes they couldn't believe their monitors), the command module had less than two hours of oxygen left. The blast also quashed the craft's ability to produce electricity, and batteries had enough charge for only three hours. With the clock running, the crew shut off systems in the module and beat a hasty retreat to the lunar module.

That was only the beginning. With the command module out of commission, several spacecraft course changes were done with the lunar module's descent engine, something the small engine wasn't designed to do. Then there was the problem of navigation; the Apollo 13 stack was surrounded by debris that glistened in the sunlight, making it impossible to get a lock on stars. Navigational readings — ones that had to be dead-on if the crew were to return — were gleaned by sighting the Sun and a tiny Earth.

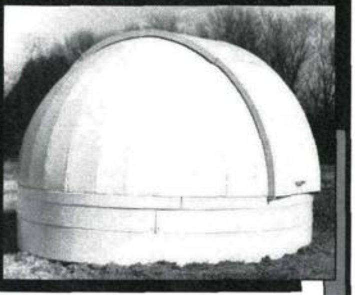
Even when they were on course, the crew grappled with high carbon dioxide levels, a lack of water, and the challenge of keeping warm (the temperature of the lunar module was between 45°F and 50°F). Because there were no water-producing fuel cells on it, all three crew members suffered from severe dehydration. Fred Haise developed a urinary tract infection that caused a high fever.

As Apollo 13 approached Earth, the crew powered up the near-freezing command module for re-entry. After they jettisoned its service module, where the errant tank was located, the immensity of the explosion sunk in — the whole side of the spacecraft had been blown away. When Apollo 13 finally splashed down, the command module had only a few minutes of battery power left and a tiny amount of oxygen in a reserve tank.

What caused the mishap? That old bugaboo: human error. During a preflight test, liquid oxygen did not drain completely from the tank. To boil off the oxygen, technicians heated the tank up to what they thought was a maximum of 80°F. But an improperly rated thermostat allowed it to reach 1,000°F. Electrical wire insulation in the tank burned away. When a stirrer was activated on the way to the Moon, electricity arced and created an explosion.

Lost Moon peels back the layers of time to reveal many unknown aspects of Apollo 13. This is the first time anyone has thoroughly woven together the mission's tale by tapping the memories of the players involved. We are reminded that space exploration is a high risk enterprise with little room for error. On the surface, the book chronicles a mission gone bad and the effort to recover from a failure. In a deeper sense, though, it documents a triumph of human ingenuity — in that light, Apollo 13 was a stellar success. Lovell and Kluger, a contributing editor at *Discover,* have made its story even more compelling. — *John Shibley*

HOME-DOME® & PRO-DOME™



- True Rotating Dome
- 6, 10, or 15 ft. Diameter
- Wide Slot Openings
- Easy Assembly
- All Fiberglass
- Complete Systems Priced from $1950

Now Available! $7.95
"AT HOME IN A DOME"
75 pages of observatory design ideas.

Technical Innovations, Inc.
22500 Old Hundred Road
Barnesville, MD 20838
301-972-8040

FREE Brochure

LOSANGELES OPTICAL CO

Telescopes, binoculars and accessories are our *only* business.

We feature a large showroom display of better-quality, major-brand instruments and accessories from such established, nationally-known vendors as: **Meade Instruments, Celestron, Bausch & Lomb, Bushnell, Edmund, TeleVue, Lumicon, Fujinon, Zeiss, Swarovski, Bogen, etc.**

Enormous selection of astronomy books, maps and charts.

Astronomy software and databases from such vendors as: **ARC Science Simulations Software, Software Bisque, Farpoint Research, CompuScope, Future Trends Software, Sky Publishing, etc.**

Knowledgeable, friendly, helpful, non-commissioned staff. Everyday low discount prices.

Meade

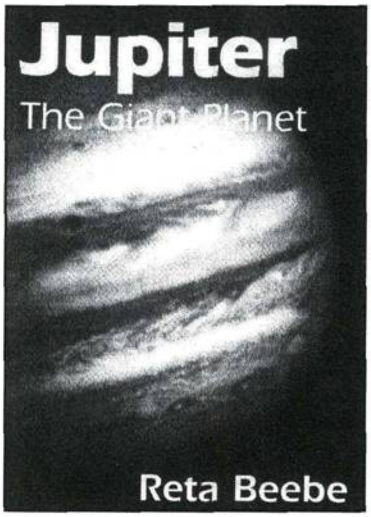
LOSANGELESOPTICALCO

MAGNOLIA
HOLLYWOOD FWY
TUJUNGA
LOS ANGELES OPTICAL COMPANY
LANKERSHIM
4870 Lankershim N. Hollywood, Calif.
VINELAND
RIVERSIDE DR
CAMARILLO
VENTURA FWY

Telescopes & Binoculars are our *only* business

4870 Lankershim Bl
(near "CLV" intersection)
N. Hollywood, CA 91601
818-762-2206

SMITHSONIAN LIBRARY OF THE SOLAR SYSTEM



JUPITER
The Giant Planet
Reta Beebe

"Astronomy professor Beebe has worked for NASA during all six Voyager encounters and as part of the Hubble Space Telescope team. . . . As Beebe describes all the wonders of the Jovian system, from the Great Red Spot to the gas-giant's weather systems, sunlike properties, and the orbits of its varied satellites, her delight in its complexity enlivens and invigorates her meticulous explanations. Beebe begins with an overview of humankind's fascination with Jupiter, from mythology to Galileo's revelatory scrutiny through the lens of the first perfected telescope, and on to the tremendously exciting successes of the Pioneer and Voyager missions. She then tackles the components of the Jovian system by first explaining its atmosphere and the planet's interior, then the discoveries associated with its satellites and rings, and finally, its magnetic field."—*Booklist*

16 color, 30 b&w photographs, 28 line illus. Cloth: 1-56098-417-1H $29.95

SMITHSONIAN INSTITUTION PRESS
Dept. 900 • Blue Ridge Summit, PA 17294-0900 • 800/782-4612 • 717/794-2148

VIRTUAL SKY

Looking for the *real* revolution in astronomy software? Want a virtual sky on your desk?

Are you looking for something fast, easy to use, informative, and fun?

Are you interested in viewing historical astronomical events in a realistic context?

Looking for software that delivers double stars? Variable stars? Eclipse animation?

What other software:

- Shows the sky as it really appears?
- Simulates binoculars and 3"-24" telescopes?
- Shows all the visible moons of the planets?
- Captures star fields to 16th magnitude?
- Displays double stars with orbit diagrams?
- Displays variable stars with light curves?

Only PC-Sky does all these things!

Isn't it time you gave us a call for more information?
1-800-827-8265. FAX (619) 463-6067
CapellaSoft P.O. Box 3964. La Mesa. CA 91944

SiberOptics

"High Tech Russian Telescopes"

6" Reflector
With Equatorial Mount and Electric Motor Drive

"Sensational Introductory Price"
$489.00
Includes: Three eyepieces (F' = 42mm; F' = 25mm Plossl; F' = 15mm Kellner)
3x Barlow; Reticle
And 6 colored filters
Also available:
4.5" for $399.00 and
2.6" Starter Telescope for $139.00

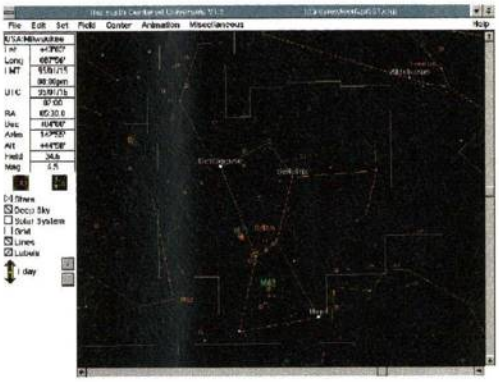
2 Year Unconditional Warranty
For Orders & Information: (800) 309-1236
24hr. Fax Line (202) 783-1839
VISA/MC Accepted

SiberOptics
733 15th St. N.W., Suite 410
Washington, D.C. 20005

Window on the Universe

Earth Centered Universe (1.5)
Nova Astronomics, P.O. Box 31013, Halifax, NS B3K 5T9, Canada, (902) 443-5989, e-mail dlane@hercules.stmarys.ca. Price: $35 ($40 Canadian); $55 ($63 Canadian) for enhanced version with SAO star catalog. Minimum requirements: 80386SX-based computer, DOS 3.X, Windows 3.X, EGA display, 700 KB of memory free within Windows (1 MB for enhanced stellar database), and hard drive with 2.3 MB of free space (5.5 MB for enhanced stellar database). Recommended: 80386DX-based computer, math coprocessor, and VGA display.

Earth Centered Universe is a planetarium-type program that displays 9,100 stars down to magnitude 6.5 (250,000 stars down to magnitude 9.5 with the optional *Smithsonian Astrophysical Observatory Star Catalog*) and more than 10,000 deep-sky objects from the Saguaro Astronomy Club database. Users can follow the motions of the Sun, Moon, planets, and up to 50 comets and asteroids from 4713 B.C. to A.D. 10,000. Adding new comets and asteroids to the list requires only the change of orbital elements in a dialog box.



Maps of the sky plot stars by right ascension and declination and employ one of three projection schemes to minimize distortion for the major portion of the display, according to its average declination. A line indicates the position of the local horizon. Future versions may include a local horizon map. Slider bars set limiting magnitudes for stars and deep-sky objects displayed.

Two circular field-of-view indicators represent finderscopes or eyepieces and a rectangular indicator represents the field of view of a CCD or 35mm camera frame. Menu selections permit flipping a sky map vertically or flopping it horizontally to reproduce the view through the eyepiece of their scopes.

Clicking on an object displays an identification window that contains the object's name, its magnitude, right ascension, declination, azimuth, altitude, rise and set times, other names and, for deep-sky objects, its size and description, using the shorthand found in *Burnham's Celestial Handbook* and the *New General Catalogue*.

Earth Centered Universe will display images of objects, but the program doesn't come with a set of images, and users must provide their own image viewer (the shareware program *WinGIF* comes with *Earth Centered Universe* but you must pay for it separately).

Users can set the time to either local time or Universal Time. Setting the observer's location can be done simply by entering latitude and longitude or by choosing a city from a list, which one can easily edit to add cities and places.

Solar system calculations have a multitude of options, including adding nutation, aberration, parallax, atmospheric refraction, and light travel time. An animation feature sets the sky in motion, stepping the view forward or backward in one-minute to four-year intervals. The feature permits adjusting the elapsed time between displayed steps from 1 to 60 seconds and leaving trails behind solar system objects to show their path against the background stars.

The program has a built-in scope controller so LX200 telescope owners can align a scope, move it to an object, and keep track of where the scope is pointing in the sky. The scope interface also works with JMI's SGT-MAX and NGC-MAX encoders and an encoder being developed by Nova Astronomics called the Micro-Guider.

Earth Centered Universe is a great choice for astronomers wanting a low-cost, Windows-based planetarium-type program. It doesn't provide the rich databases some of the more expensive programs do, but the ample deep-sky database should keep most observers happy. — *Dave Bruning*

Image The Home Planet

Every day a fleet of Earth orbiting weather satellites image our planet. These images are relayed over shortwave radio and transmitted directly from the satellites. SSC makes the hardware and software that will let you connect your IBM PC compatible computer to a shortwave, or other radio, so that you can receive these images.

Whether you are ready to study global warming, track storms, or just see if it is worth packing off to your favorite dark sky site, SSC's weather facsimile products are for you.

At $99, our entry level system includes the radio to computer interface, software, manual and tutorial audio cassette. Software and interfaces for direct satellite reception start at $250. All packages include our image processing software with advanced features like false colorization, time lapse frame looping, zoom, scroll pan and many other features.

PC HF Facsimile $99

Complete shortwave systems including radios, antennas, software and interfaces are as little as $399. Complete systems for direct satellite reception start at $499. Call or write for our free product catalog.

Software Systems Consulting
615 S. El Camino Real, San Clemente, CA 92672
Tel: (714) 498-5784 • Fax: (714) 498-0568

International
Dark-Sky
Association

You can help:

- conserve energy
- reduce air and light pollution
- save the night skies for everyone to use and enjoy.

To learn about *light pollution, energy waste, light trespass,* and related issues, or to join, ($20 basic membership), write to the non-profit **International Dark-Sky Association,** 3545 N. Stewart Ave., Tucson, AZ 85716 U.S.A.

Earn $4,000 Per Month From Your Home With A Computer!

FREE *CBSI 486 Computer*

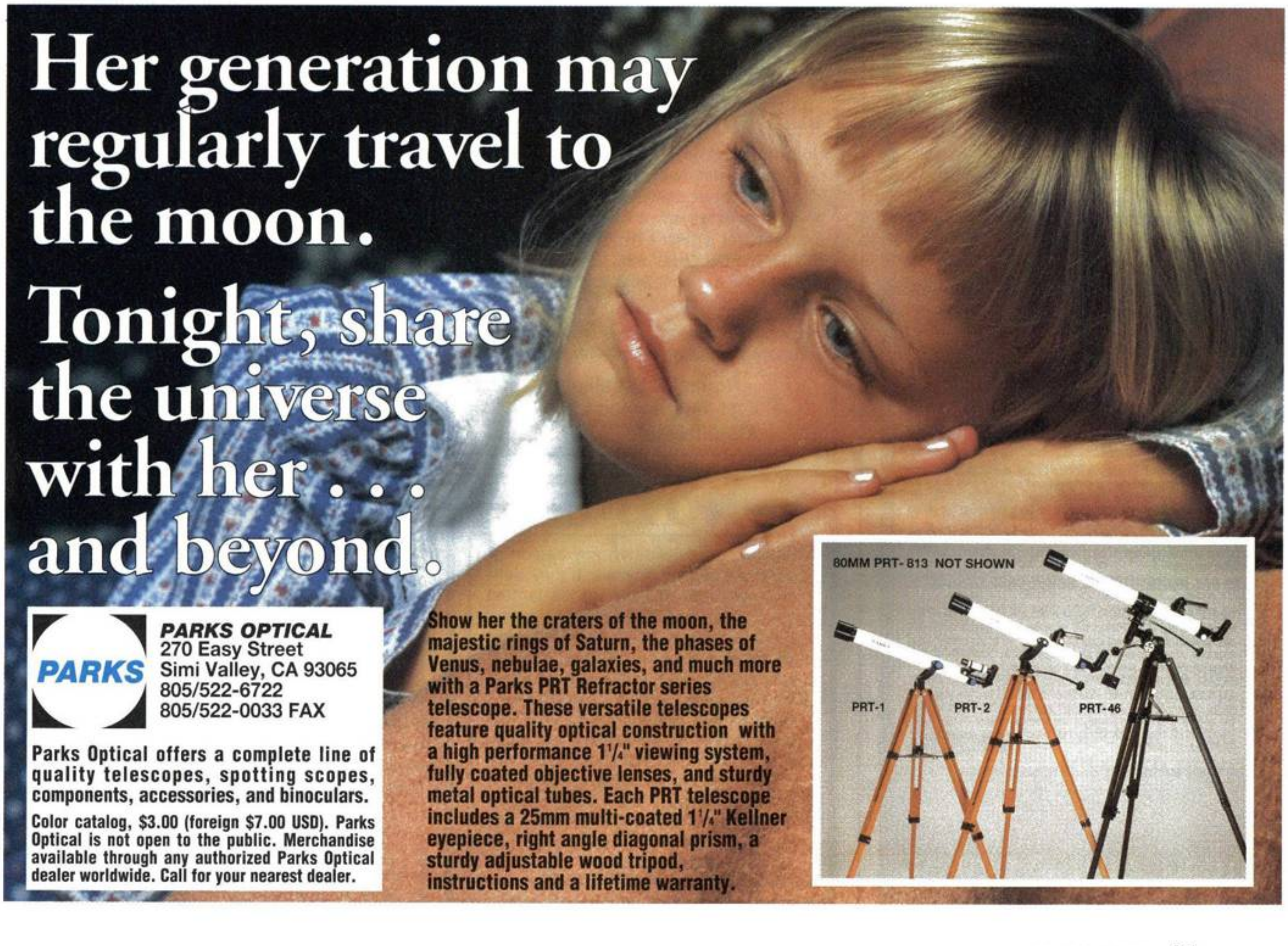
Begin part-time and still retain the security of your present position. This is a proven turnkey business an individual or couple can run. If you purchase our software and business program, we will give you the computer and printer. If you already own a computer, you may receive a discount. You do not need to own, or know how to run, a computer — we will provide free, home office training. Financing available.

To receive free cassettes and color literature, call toll-free:

1-800-343-8014, ext. 82

(in Indiana: 317-758-4415) *Or Write:*

Computer Business Services, Inc.
CBSI Plaza, Ste. 82, Sheridan, IN 46069


Her generation may regularly travel to the moon.
Tonight, share the universe with her . . . and beyond.
80MM PRT-813 NOT SHOWN
PRT-1
PRT-2
PRT-46

PARKS

PARKS OPTICAL
270 Easy Street
Simi Valley, CA 93065
805/522-6722
805/522-0033 FAX

Parks Optical offers a complete line of quality telescopes, spotting scopes, components, accessories, and binoculars.

Color catalog, $3.00 (foreign $7.00 USD). Parks Optical is not open to the public. Merchandise available through any authorized Parks Optical dealer worldwide. Call for your nearest dealer.

Show her the craters of the moon, the majestic rings of Saturn, the phases of Venus, nebulae, galaxies, and much more with a Parks PRT Refractor series telescope. These versatile telescopes feature quality optical construction with a high performance 1¼" viewing system, fully coated objective lenses, and sturdy metal optical tubes. Each PRT telescope includes a 25mm multi-coated 1¼" Kellner eyepiece, right angle diagonal prism, a sturdy adjustable wood tripod, instructions and a lifetime warranty.

Precision Solar Filters

Thousand Oaks Optical solar filters are recognized around the world for their quality, consistent density and even coating across the entire aperture. We specialize in solar filters only and are the largest solar filter manufacturer in the world. Filters are available to fit all brands of telescopes and binoculars. **Thousands of our filters are in use around the world. The preferred choice of telescope dealers and exclusively used by NASA aboard the Space Shuttle.**

GLASS (Full Aperture) Type 1

Made from high quality hand select glass, machine polished and **TRIPLE COATED** with a Nickel-Chromium alloy. Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

Aperture	Mounted	Aperture	Unmounted
2.4"	$49.00	2.4"	$39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5 to 4"	49.00
4-1/4" to 5"	74.00	4-1/4" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
12.5" to 13.1"	149.00	12.5" to 13.1"	129.00
14"	169.00	14"	149.00

40mm to 80mm Binoculars - Mounted .... $92.00 pr.

GLASS (Full Aperture) Type 2

Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

Aperture	Mounted	Aperture	Unmounted
2.4"	$62.00	2.4"	$52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5 to 4"	66.00
4-1/4" to 5"	96.00	4-1/4" to 5"	86.00
6"	105.00	6"	95.00
8"	125.00	8"	109.00
10"	139.00	10"	129.00
11"	149.00	11"	139.00
12.5" to 13.1"	179.00	12.5" to 13.1"	159.00
14"	199.00	14"	179.00

40mm to 80mm Binoculars - Mounted .... $115.00 pr.

GLASS (Full Aperture) Type 3

Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 & type 2. Type 3 filters are for photographic use only.

Aperture	Mounted	Aperture	Unmounted
2.4"	$79.00	2.4"	$65.00
3.1"	82.00	3.1"	69.00
3.5" to 4"	99.00	3.5 to 4"	79.00
4-1/4" to 5"	125.00	4-1/4" to 5"	110.00
6"	135.00	6"	115.00
8"	159.00	8"	139.00
10"	172.00	10"	152.00
11"	199.00	11"	179.00
12.5" to 13.1"	229.00	12.5" to 13.1"	209.00
14"	259.00	14"	239.00

Types 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

5 year warranty on Type 1, 2, & 3 filters
Threaded camera filters also available.

H-ALPHA PROMINENCE FILTERS.
Priced from $699-$859 complete & ready to attach to telescope. Please call or write for additional information.

PRICE GUARANTEE: If you see a lower advertised price on any competitive brand glass filter, simply note the brand and we'll automatically match it.

Our 15th year of manufacturing solar filters.

SOLAR ECLIPSE VIEWERS

Mylar

Aluminized on both sides. Mounted in rigid frame. Mylar window: 1-5/8" x 3-1/8". Each filter supplied in individual envelope. Light transmission is blue.

3" x 5" Overall size .... $1.00 ea.

Plastic

Same as Mylar except this filter yields a sharper image with orange transmission

2-5/8" x 4-5/8" Overall size .... $2.00 ea.

Minimum order of 10 eclipse filters in any combination. Please add appropriate shipping/handling. 10 units: $3.00. Plus $1.00 for each additional 10 units. Minimum credit card order of $25.00. Quantity discounts available starting at 100. Designed for naked eye visual use.

Free brochure available. Foreign inquiries: Please include $1 for return airmail postage of brochure. Proforma invoices available upon request.

30 DAY UNCONDITIONAL MONEY-BACK GUARANTEE

ORDERING INFORMATION: Glass filters are shipped free within the continental U.S. (Please call or write for shipping cost outside of the U.S.) Payment may be made by personal check, bank check or money order. We also accept **VISA, MasterCard and American Express.** (No bank hold on personal checks.) **PLEASE SPECIFY TELESCOPE BRAND AND/OR OUTSIDE DIAMETER MEASUREMENT OF TELESCOPE TUBE.** The cost of the filter is determined by the telescope aperture. The mounting cell fits over and around the end of the telescope tube (friction fit). Unmounted filters are the glass filter without a mounting cell.

ORDER TOLL FREE - U.S. & CAN.
(800) 996-9111
ORDERS & INFORMATION: (805) 491-3642
(MON-FRI 10-5 PM PACIFIC)
FAX (805) 491-2393 (24 HOURS)
THOUSAND OAKS OPTICAL
Box 4813 Dept. A • Thousand Oaks, CA 91359

★ ★ **Star Hill Inn** ★ ★
an astronomer's retreat in the Rockies
Astronomy & Nature Workshops!
Come for a dark sky vacation...bring your 'scope or rent one of ours! Charming private cottages, 7200' elevation. Easy access to Santa Fe, Taos, Pecos Wilderness & Wildlife Refuges.
Open year-round, reasonable rates. For free info:
Star Hill Inn, Sapello, New Mexico 87745
505-425-5605

Tell advertisers you saw their ad in ASTRONOMY.

CCD IMAGING EQUIPMENT™

- Cameras
- Filter Wheels
  Manual & Remote
- ALL CCD Filters
- Flip Mirrors
- Beam Splitters
- 1.25, 2-in. & T-mounts

Equipment for **ALL** CCDs **AND** visual use

$549

Flip Mirror w/ Filter Wheel

MURNAGHAN™ Instruments
1781 Primrose Ln., W. Palm Beach, FL 33414
Phone: 407-795-2201 • FAX: 407-795-9889
Internet: murni @ bix.com
BBS 407-795-0979

NOW AVAILABLE
JUPITER COMET-CRASH VIDEO

Unique, historic, spectacular color video recording. Clearly shows, in real-time, large video images of multiple comet impact sites taken from Brazil with a Celestron 8 telescope over several nights. **THIRTY MINUTES OF HISTORY FOR ONLY $35. DON'T MISS IT!!!** We also sell low-cost B&W and color real-time video cameras.

For information send a large 9-by-12-inch self-addressed envelope with 4 stamps to:

Roger W. Tuthill, Inc.
11 Tanglewood Lane
Mountainside, NJ 07092

NOTICE

Please be advised that any person or company making claims that they were once affiliated with the world's largest solar filter manufacturer, Thousand Oaks Optical, and that their filters offer an identical view, is not true. The person making these claims was employed as a part-time assembler for Thousand Oaks Optical. We hereby disavow any responsibility for the **safety** and quality of their product, nor should it be construed that it's the same as ours. For the past fifteen years the product safety and reputation of glass solar filters has been achieved by the owner of Thousand Oaks Optical.

MEETINGS & EVENTS

January 4–7
Venus II, Tucson, Arizona. Contact Amy Schumann, University of Arizona, Tucson, AZ 85721, (602) 621-2902. The address of the home page on the World Wide Web is http://titan.lpl. arizona.edu/ hypertext/venus2.html.

January 8–12
The 185th Meeting of the American Astronomical Society, Tucson, Arizona. Contact the American Astronomical Society, 2000 Florida Avenue, NW, Washington, DC 20009, (202) 328-2010, e-mail aas@aas.org, or fax (202) 234-2560.

February 4–5
2nd Annual Northwoods Winter Starfest, Fall Creek, Wisconsin. Sponsored by the Chippewa Valley Astronomy Society. Contact Ray Forsgren, 4856 Inlet Drive, Chippewa Falls, WI 54729.

February 27–March 5
Winter Star Party, Camp Wessumkee, Key West, Florida. Sponsored by the Southern Cross Astronomical Society, Inc. Contact Bob or Sharon Grant, 5401 SW 110 Avenue, Miami, FL 33165, (305) 595-8778.

March 13–17
26th Lunar and Planetary Science Conference, Houston, Texas. Cosponsored by the Lunar and Planetary Institute and the NASA Johnson Space Center. Contact LeBecca Simmons, LPI Publications and Program Services Department, 3600 Bay Area Boulevard, Houston, TX 77058-1113, (713) 486-2158.

March 18
Astrophoto XI, California. Sponsored by the Ventura County Astronomical Society. Contact Linda Lippman, P.O. Box 982, Simi Valley, CA 93062, (805) 520-0206.

March 24–27
MEPCO '95, Violau, Germany. Sponsored by the Working Group of Planetary Observers of Germany. Contact Wolfgang Meyer, Matrinstr. 1, D-12167 Berlin, Germany or Daniel Fischer by e-mail at p515dfi@mpifr-bonn.mpg.de or fax 49-2244-80298. ☐

Please submit announcements at least four months before the date of the event. When writing to organizations listed here, include a self-addressed, legal-sized envelope with your request.

★ BEST VALUES - LOWEST PRICES! ★ ★ TELRAD ★ PARKS ★ BUSHNELL ★ BRANDON/VERNONSCOPE ★ SCORPIUS ★ ASTRO SYSTEMS ★ SKY PUBLISHING ★ ★

NEW 4 1/2" REFLECTOR
(3) EYEPIECES
EQ MT. $269

LOWEST GUARANTEED LISTED PRICES!

NEW C8-C11
ULTIMA 2000
COMPUTER - GO TO
TELESCOPE - CALL

NOW AVAILABLE

9X60 R/A ILL.
FINDER + BKT.
$159. MEADE

SEE MEADE AD
Authorized Meade Dealer
WE ARE A FULL LINE MEADE DISTRIBUTOR

SEVEN DAYS A WEEK 10 to 10

CELESTRON $AVE

NOTICE: LOWER PRICE FOUND? JUST GIVE A CALL!
* CLOSED XMAS & NEW YEARS DAY *

TELESCOPES SCH/CASS.
C5, (AC/DC) **C8** Classic,
GPC8, **C8 +** Computerized,
C8+, Ultima C8, C8/11 2000
CG11, **C14**, **C14** Computerized .... **Lowest Prices**

LATEST MODELS WITH CROWN GLASS

TELESCOPES REFLECTORS
C4.5, 7.9" f4(RFT) .... Call For **BEST Price!**
TELESCOPES REFRACTORS
First Scope 80, 60, 90F, GP 102, GP102 ED, GP102F
SPOTTING SCOPES
C90 all models, S50, C60RC, 20x60 WP, 20x60 Ed-WP, 30x60 WP, S80, S80+, C5, C8, 500Mmm. f 5.6 .... **CALL**
BINOCULARS - PRICED TO SELL!
Monoculars 5x20, 8x25, 6X16
Mini 8x25, 8x22, 10x25, 8x24PP, 10x24PP
NATURE 7X35, 7X50,8X42
Pro 8x30, 7x50, 10x50, 12x50, 8x56, 9x63, 8-24x50 Zoom
ULTIMA 8x32, 7x42, 10x42, 7x50, 10x50, 8x56,
ED SERIES 6.5x44, 9.5x44
Water Proof 8x21, 8x30, 12X80mm
Giant 16x70, 11x80, 15x80, 20x80, 20x100 mm, ... **CALL**

UNBEATABLE PRICES

OPTICAL TUBE ASSEMBLIES

C8" Optical Tube Assem. Star Bgt.	$695
GP 102........$595, C11......CALL, C14	$3999

ULTIMA EYEPIECES

5, 7.5 12.5 mm	ea $70
18mm, 24mm, Ultima 1 1/4"	ea $74
30.........$87, 35.........$103, 42mm	$99
45 60mm 2".....ea $158, 80mm	$219
OR 6, 7, 9, 12mm (96")	ea $35
KE 10mm 16, 18 25 30 40 (96")	ea $30

PLOSSL OCULARS NEW CELESTRON SERIES

1 1/4" 7.5, 10, 17, 26mm...$46 .. 40mm PL...	$54
(.96) 7.5, 10, 17, 26mm PL...	$42
Zoom 6.5-18, 1 1/4" ORTHO.	$113
25mm K 1 1/4" Multi-Coated	$35
4,5,6,12 Ortho (Multi-Coated) 1 1/4"	ea $49
18 25mm 2" SPECIAL PURCHASE	ea $74

REVOLUTIONARY LANTHANUM EYEPIECES -LV SERIES - STATE OF THE ART - RARE EARTH GLASS -

2.5 mm , 4mm, 20MM,25MM, 1 1/4"	$102
5mm, 6mm, 9mm, 10mm, 15mm.....$95, 30mm., 2" ...	$130
Coma Corrector Photo-Visual 1 1/4" - 2"	$168
Micro Guide Eyepiece	$145
6mm ILLUM-Reticle 1 1/4"	$154
Adapter 2" to 1 1/4"	$13

T-RINGS

(State Camera Make Model) All	$10 EA

ACCESSORIES

AC Adapter (PEC)	$21
Accessory Case -DELUXE-	$43
Barlow Lens 2x96".(Deluxe).....$24, 2.5 x	$24
Barlow Lens 1 1/4" Short type (NEW)	$54
Barlow 2 x Ultima G4	**BEST Price!**
Barlow 3 x 1 1/4"	$39
Barlow Lens 2x2" m/c (Giant)	$69
Battery XP14 (For Finder - ILL.RET.)	$8
Binocular Tripod Adapter	$14
Car Batt. Adapter Ultima (PEC)	ea $19
Car Window Mount	$29
Carrying Case - Powerstar 8 Custom ULTIMA	$138
Counterweight Bar Assem -8" .... $58 11"	$63
Counterweight Set - 8" (Standard) $48, C5	$55
DC Inverter (110V)	$73
Drag Erect Image - 45° 96" .... $42 45° 1 1/4"	$41
45° 96" to 1 1/4" DIAGONAL	$43
DEC Motor (PEC) 8/11, Ultima-Powerstar, Classic 8 ...	$99
DEC Motor C4.5 and SP MT	$59
Deluxe Lat Adjuster (DLA) C8	$30
Dewstar (Lens Shade - 8")	$24
Advanced Astro Master (ATM) (SP)	$399
Drive Corrector - Heavy Duty	$358
Drive C8 Quartz Sing Axis (C8 - Classic)	$195
Expanding Bushing - 96" to 1 1/4"	$14
Filter (All Colors) 2" (Eyepiece)	ea $19
Filters #1A 8 12 15 21 23A 25 38A 47 56 58 80A 82A 96ND 50% 96ND 25% 96ND 13% Polarizer	ea $10
Filter Sets (Set of 6) .... $59 (Set of 12) ..	$108
Filter - Series 5 or 6 (6 ea. in Set)	$49
Filter Adapter - 96" .... $11 1 1/4"	$15
Finderscope 8x20 for C90-erect image....$54 BKT	$12
Finderscope 5x24 STG ...$29 6x30	$39
Finder Bracket (Quick Release) 8X50	$45
7x50 III POLAR AXIS	$135
R/A w/Polar Align Reticule - 8x50 Ultima w/BKT	$154
Focus Motor - C8,Classic 8, PWR STAR	$105
Image Corrector - .96 18mm Eyepiece	$15
Large Accessory Ring (LAR) C90	$21
LED Flashlight	$13
Lens Shade - C90......$53, C5.....$48, C8......$24 C11	$138
LPR Filter(Nebular #2.....$129, #5	$79
#7.....$89, "A"....$54, "B"...$79, C"...$75, "D".(Bin.).....	$83
Motor Drive-for C4 5 w/Dr Single Ax.(DC)	ea $158
Motor Drive S A (AC) Pol/Sp C4.5, SPC6, SPC8	$88
Motor Drive w/Dr. Dual Axis SP (DC) & GP	$248
Multiple Ocular Holder 96".....$62, 1 1/4	$119
MFFT 55 (Multi function focus-tester)	$133
Photo Tripod Adapter 8" (Opt Tube)	$50
Photographic Tripod Deluxe Slow Motion Controls	$39
Piggyback Mount 8"..........$31, C5.....$55 11 14 ...	$54
Piggyback Mount SPC 80 SPC6, SPC 102	ea $21
Polar Axis Finder w/Illum (for C4 5, C6, C80 SP)	$68
Polorizer Set (.96) (Variable)	$31
Polarizing Filter Set - 1 1/4" (Variable)	$42
Porro Prism - 965.....	$39
Radial Guide Assy Off Axis	$110
RFA (Rich Field Adap) f5	$89
Refractor Accessory Ring	$18
Reducer/Corrector Lens f6 3	$113
Reducing Bushing = 1 1/4" to 96"	$16
Filter Set - Series 5 (six) .... $49 Series 6 (six)	$57
Skylight Filter Dust Seal (5/8/11/14)	$34
Solar Filter - C90 C102 C4 5	$63
5" Off Axis - C11......$109, C8.....$98 C60 C80	$38
Sky sensor computer (SP-GP) Motors	$113
Star Diagonal (.96) .....$21, Star Diagonal 1 1/4"	$38
Star Diagonal 1 1/4" w/Multicoatings	$44
Star Diagonal (Mirror) 2" Deluxe Adjustable (PRO)	$218
Star Diagonal 2" (Mirror)	$120
Stereo Binocular Viewer	$429
Super Polaris Half Pier + (GP)	$112
GREAT Polaris Mt & Tripod...	$679
T-Adapter C90, C5,C8, C11, C14	ea $22
T-Adapter - C90........$29, S-80	$24
T-C 16mm Adapter	$28
Spotting Scope Tripod.........$94, Mini Tripod	$28
Tele Extender- Deluxe.....$42, Tele Extender	$22
TeleExtender- Refractor-Newtonian	$43
ALT. EZT. MOUNT TRIPOD (NEW)	$269
Tripod - Adjustable C5, C8.....$219 mini	$27
C8 Tripod (Oak) $195 11/14	$468
VSP (Vibration Suppression Pads)	$38
Visual Back - 1 1/4" (Eyepiece holder)	$26
Wedge - C8.....$85 Heavy Duty 8".....$198 11/14	$368
Wedge UII (Heavy Duty)	$359

PUBLICATIONS - BOOKS

Owners Manuals, Acc. Catalog	ea $9
Binocular Buyers Guide Book by Alan Hale	$6
Sky Maps............$11 (Quantity Price)	ea $10
Star Atlas (North & South) 2000.0..$19 Planisphere	$6
Photography with your telescope	$6

MISCELLANEOUS

Lens Caps.........ea 50¢ Accessory Tray	$29
f4 Reducer lens (for 500mm telephoto)	$83

★ ★ ★ ★ OFFICIAL ★ MEADE ★ CELESTRON ★ B&L ★ AUTHORIZED DISTRIBUTORS

MEADE

CLUBS/ SCHOOLS SPECIAL QTY PRICES

TELESCOPES **CALL!**

2045 Spotting Scope, 2045D	
90mm Alt.Z. W 1.25" Eyep. IN STOCK	**SPECIAL**
90mm Equit. W 1.25" EyeP IN STOCK	**SPECIAL**
2 4" (60mm) Alt. Refracting Telescope 1.25"	$124
2 4" (60m) Equatorial Refracting Telescope	$149
Refractors - LARGER SIZES **CALL!**	
4 1/2" Reflecting Telescope Heavy Duty Mount	$298
SN 8-8" f4 SCH/NEWT. f4.5 O.T Assy	$795
Newt. Reflectors 6", 8", 10", 16"	
REFRACTOR OPTICAL TUBE ASSY'S	
2080 f10 MC/OG WEDGE TRIPOD	$1149
COMPUTERIZED 2120 -10 in. f6.3	$2595
2060 16" f/10 SCH/CASS AVAILABLE NOW	

ACCESSORIES

Equatorial Wedge plus Tripod 2045 ★ Super Wedge 10"	
Equatorial Wedge for Model #2080, #2045, #2120 ★ Mounts	
Field Tripod for Model #2080, #2120	
Altazimuth Adp. for Field Tripod (#2080, # 2120)	$18
Deluxe Latitude Adjuster 2080 or 2120 ★ Magnetic Compass	
Azimuth Control (for Field Tripods for 2080)	
#603 DC Cord (25') w/cigarette plug	
Eyepiece Extender Tube only ★ Off-Axis Guider Body only	
Illum Ret Eyepiece Sys 1.25" 12mm, 9mm	
Spotting Scope Adp.Plate 2120, 2080	

EYEPIECES

Mod. Ach. (965) 9 12 25 40mm	$37
Telecompressor System (f5) ★ F 6.3 Focal Red./Field Flattener	
Mod. Achromatic 1.25" 9,12,25,40mm	$29
Series 3000 Plossl 1 1/4" 5,6.7,9.5,16,25mm	$59
40mm PL 1 1/4"	$79
1.25" Orthos 4mm, 6mm, 9mm, 12.5mm M/C	$49
Sup Plossl 1 25" 6 4, 9 7, 12 4, 15. 20, 26mm	$84
32mm, 40mm, 1 25".....ea $98, 56mm, 2"	$213
13 8mm Super Wide 1 25"...$122 ★ 18mm 1 25"	$119
24. 5mm 1 25...$145 ★ 32mm 2"...$219, ★ 40mm 2"	$246
4.7mm 1 25"...$152 ★ 6.7mm 1 25"	$173
8. 8mm 1 25"/2 $219 14mm 1 25"/2"	$248

Eyepiece Holder, 1 25" ★ #915 Diagonal Prism .965 (90°), #917 Hybrid Diagonal Prism 965/1 25", #918 Diagonal Prism 1 25" ★ #929 2" Diag. Mirror inc. eyepiece adapter with 1 1/4" Adpt. ★ #930 Diag Mirror 2" OD Barrel for 2" Focuser Sleeve ★ #924 Erecting Prism 1 25" (Porro Type), #927 Erecting Prism 45° Diag. (.96), #928 Erecting Prism System 45° 1 1/4" ★ #912 Roof Prism 965, ★ #931 Hybrid 45° Erecting Roof Prism .96 - 1 1/4"

FILTERS - WHY PAY MORE! - ACCESSORIES

Photo Vis. Color Fil. & Pol. 1 25" All Col. Avail ★ Filter Sets 1 1/4" (4) #1, #2, #3, ★ Set of 6 Photo Visual Filters (965) Thread In ★ Series VI Drop-In Filter Set (2045, 2080) ★ Series V Set (90B, 97D, 97E, 97ER) ★ #905 Variable Polarizing Eyepiece System 1 25" ★ #908 Nebula Filter 1 25" (B) (N) ★ #910 2" (B) (N) ★ #911 (rear cell Thread on) (B) (N) ★ #122 2X Tele-negative Amplifier 1 1/4" ★ #126 1 1/4" Barlow (2045.4500) ★ #127 2X-3X Variable Tele-negative Amplifier ★ #131 2X Tele-negative Amplifier 965 ★ #140 2X Tele-neg Amplifier ★ Sun Shade (97) (2045) ★ Dew Shield 8" 2080, 2120 10" ★ #1A Skylight Filter/Dust Seal ★ #50A Acc'y Case (PROMO 50), ★ #50 Acc'y Case, (2045S) (97SS) (2045D) ★ #1401 Tube Balance Weight System 2080...$79 ★ 5X24 Right Angle...$59 ★ #1402 Tube Balance Weight System 2120 ★ Extra Counter-weight 25lb, 1" OR 1 1/2" ★ #1206-1205 Elect. Focuser ★ #680 Deluxe Focuser 1 25" & 2" ID ★ #60, #61, #62 T-Adapters ★ Tele-extender Tele-extender (Variable) ★ Basic Camera Adapter 1 25" 929" (.96) ★ Variable Projection Camera Adapter 1 25" ★ 2" Prime Focus Adapter (.96) ★ T-Mount Camera Ring Adp'rs (Spec. Camera & Model) ★ Piggyback Bracket 2080/2120, 2045 ★ #957 9x60 Finder Scope ★ #967 9x60 R/A Polar III ★ #637 6X30MM View Finder + Bkt. ★ #544, #545, 8x50 View Finder ★ Electric Motor Drive AC or 12 VDC + TASCO 4500 ★ #55 Manual Declination Cont., #65RS ★ 48RS Dual Axis Dr. Corrector Sys. ★ 65 RS DEC Control ★ #43 RA Drive Corrector ★ #46 Dual Axis Drive #47M DA Dr. Corrector Sys ★ 8000 OBJECT LIBRARY (2-5) CONTROL BOX LX5 ★ #39 Dec. Motor ★ 39S DEC MOTOR ★ #868 Extension Tube (for 2" eyepiece) ★ Vinyl Dust CAP for 16", 10", 6"...$26, pair 8"...$28 ★ Accessory Shelf for 6"-8"-10"-16", Acc. Shelf for Field Tripod ★ Mirrors, Eq. Mounts - Please call for quotes

BAUSCH & LOMB

BINOCULARS ★ Elite (BK) Armored PC-3 Coated ★ 7x36, 8x42, 10x42 ★ Discoverer - fog-waterproof compacts ★ 7x24, 10x28 (BK) Armored C. F. Porro Prism ★ Astronomical-Terrestrial ★ 11x80 C.F., 20x80 C.F. ★ Custom ★ 8x36 Long Eye relief C.F./P.P. ★ 7x6 Long Eye relief C.F./P.P. ★ Legacy ★ 7x35 Extra WA (BK) Armored ★ 8x40 Extra WA (BK) Armored ★ 10x 50 Extra WA (BK) Armored ★ 7-15x35 Zoom (BK) Armored ★ 8x24 Compact, Armored P.P. ★ 8x20 Roof Prism Armored ★ Auto Focus ★ 10x25 WA Glasses on ★ 7x35 WA (Blue Armored) ★ 10x50 WA (Blue Armored) ★ Nature View ★ 8x42 ★ Mini Compacts ★ 8x21 C.F., P.P.(BK) or (GRN) ★ Spectator Series-insta-focus ★ 7x35 WA Armored (GRY) ★ 8X40 WA Armored (GRY) ★ 10X50 WA Armored (GRY) ★ 7-15X35 Armored (GRY) ★ 7-15X40 Armored ★ Spectator ★ Compact ★ 10x50 WA ★ 8x22 compacts (BLK) or (CAMO) ★ Powerview ★ 7x35 WA 8x30 (BK) armor ★ 10x50 WA (BK) or (CAMO) ★ 8x25 compact (BK) armor ★ 7-15x35 Zoom (BK) Armored ★ 8x21 Roof Prism (BK) Armored ★ 10x25 Roof Prism (BK Armored ★ 7-21x40 zoom (BK) Armored H Harbormaster Brass Telescope ★ Discoverer 15x60 x -60mm ★ 8080 Telephoto 800mm ★ Elite-Spotting Scopes ★ 77mm77mm ED ★ 60mm, 15-45x60mm ★ Spacemaster Spotting Scope ★ 60mm, 60mm (CAMO) 15-45x Zoom ★ 60 MM ED (Prime Glass) ★ Eyepieces 15/20/22 WA/25/45/60/ 15-45 x Zoom ★ Banner Sentry- 50mm ★ Compact Competitor 40mm ★ Banner Stalker 50mm ★ Sportview Zoom 15 x 45/ 20-60x ★ Compact Spotting Scopes ★ Terrestrial Scopes ★ Roof Prism Armored Monocular 8x20 ★ Astronomical Scopes ★ Professional 560-560 x 4 1/2" ★ 454 x 60, 450 x 60, 345 x 60, 565 x 60 mm ★ Rotary Power 360, 500 ★ Compact 300x60, 455x60, 455x60 ★ Mercury 150 z 50, 208x50, 280x60 ★ Tripods Pro, Field, Table Top, Window Mt. ★ **ENSIGN** ★ 8x25, 10x25, 7x50, 8x40, 10x50, 7x25 ★ Water Prode ★ 7x50 (BK) or (YEL) ★ 8x36 ★ Concert-Opera ★ 3x23, 3x25, 3x28, 5x25 ★ Pearl, Gold, Blk ★ Economy ★ 7x35 Extended Eye Relief ★ 7x35 Fastview Focus Free ★ 7x35, 10x50 Falcon ★ Glass On ★ 7x35, 10x50, 8x40 Armored P.P. ★ 8x21, 7x35 WA Perma Focus ★ SE-R ★ 7x35 WA, 7x50, 10x50 ★ Perma Focus 2000 ★ 7x35, 7x35WA, 10x50 Wide Angle, 7x50, 7x21, 8x21 (bk) 8x21 (CAMO) 7x35 EWA, 10x50 EWA, 10x25 P.P. ★ 7x50, 7x42 Waterproof ★ Perma Focus 500 ★ 8x21, 10x25, 7x25, 7x35, 10x00WW ★ 10x50 WA ★ Mercury ★ 7x25, 7x50, 10x50WA, 7x35WA, 7x35, 8x21, 10x25 ★

✯ NO APD PRODUCTS EXPORTED ✯

CALL US LAST WITH YOUR LOWEST TELESCOPE-ACCESSORY PRICE QUOTE!

WHOLESALE OPTICS DIVISION

MAIL ORDERS TO:
29 KINGSWOOD ROAD
DANBURY, CT 06811
TEL: (203) 746-3579
FAX : (203) 746-7572 (24 HRS)
FAX ORDER LINE ONLY

• PUBLIC WELCOME • NO SALES TAX •
• SHOWROOMS: 57 NORTH STREET/SUITE 401, DANBURY, CT 06810 •
BUSINESS OFFICES SAT 11 to 5PM •
• PHONE ORDERS 10AM -10PM (7) DAYS A WEEK •
Buyers Guide - CATALOGS

JCB 3% Credit Charge VISA

Telescope Accessory Catalog/Data Pack (2lbs)...$10 refundable	
Catalog pkg. (Telescopes - Spotting Scopes - Accessories -Binoculars) (3lbs)...	$15
Catalog Charge (Out of USA) .....$29 Minimum shipping Charge (via UPS)......	$5
(CT Tax for in state sales only) Minimum shipping - Foreign Orders	$29.00

PARKS
20 INCH
f5 + 5 INCH
SECONDARY
$2395

★ ★ ★ MOST ORDERS SHIPPED SAME DAY ORDERED ★ ★ ★ ★ ★

BAUSCH & LOMB
(INTERNATIONAL DEALERSHIPS AVAILABLE)
Binoculars • S. Scopes • Wholesale +
BAUSCH & LOMB ACCESSORIES

PROFESSIONAL SERIES PL OCULARS 26mm...$49 16.3 ER....$49 / A.S.PLOSSL /12.mm...$39ea / 6mm OR...$45/ ZOOM ORTHO 8 to-21mm...$79 / 50mm RAM...$29 FILTERS SERIES 6 DROP-INSET (6)..$49 WITH CASE / EYEPIECE ADAPTER..$49 / RFT ASSY ..$89 4X FINDER (4000)..$29/ MEASURING RETICLE EYEPIECE..$79/ PIGGYBACK MOUNT (4")...$21/ (6" & 8") ..$29/ DYNA-TRACK AC/DC DRIVE CORRECTOR ...$129 ./TRIPOD...6000/8000....$159 / 4000....$79/ MOTOR DRIVE (110 OR 220V)....$49/ TELESCOPE...$749 / 6000A 6" SCH/CASS

6" MAKSUTOV $1295
6" MAK-INTES O.T...$729

CELESTRON 12V Battery +
Recharger7 AMP...$63 12 AMP...$73

BINOCULARS

7X42 Ultima	$185	7x50 Ultima	$244
8X32 Ultima	$181	8x56 Ultima	$274
10x42 WA Ultima	$221	10x50 Ultima	$254
11x80MC	$295	15x80MC	$315
20x80MC	$324	9x63 Pro	$199

GP 90 F 3 1/2"
REFRACTOR $1895

IMPORT - EXPORT
A WORLD CLASS DISTRIBUTOR TO INDUSTRY - GOVERNMENT-PRIVATE AND PUBLIC EDUCATIONAL INSTITUTIONS.
RETAIL ACCOUNTS

ALL PRODUCTS AT XMAX-HOLIDAY SPECIALS
★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

630 FMTRSX	$339
8X30 FMTRSX	$338

ALL MODELS .... CALL...
COMPARE AND SAVE!
FUJINON

7x50 FMT RC-SX	$471
7X50 FMT-SX	$371
7X50 FMTR-SX	$414
10X70 FMT-SX..$469, 16X70 FMT-SX .	$519
TRIPOD BKT.	$14

CCD'S CALL!
MOST MODELS IN STOCK

FILTER SPECIALISTS
H.R. SERIES - HIGH RESOLUTION
- PHOTO -VISUAL 1 1/4" FINEST AVAILABLE!
"WORLD'S LARGEST SELECTION"
#1A #8 #11 #12 #15
#21 #23 #25 #29 #47
#56 #58 #80 #82A #85
#96ND - 50% #96ND - 25% 96ND - 13%
POLARIZER, (2) for VARIABLE PO..
2"...$12 EA. $11 EACH MADE IN U.S.A.
6 FILTERS ......$59, 12 FOR $108
18 FOR $162
EXCEPTIONAL FOR CCD

DOBS! CALL
6 INCH TO 16 INCH

TELRAD + BASE $39
WITH DEW SHIELD

EQUATORIAL MOUNT............$99
EQUATORIAL MOUNT HEADQUARTERS

★ ★ BUY DI ★ ★

TRADE-INS CONSIDERED ★ WE HAVE EVERYTHING AT WHOLESALE OPTICS ★ TELEPHONE ORDER LINES 7 DAYS A WEEK ★ 10 AM TO 10 PM ★ (203) 746-3579 ★ WE HAVE IT ALL ★ ★ ★ ★ ★

★ UNIVERSITY OPTICS ★ JASON ★ VOGEL/DIGITRACK ★ TIFFEN ★ DAVIS & SANFORD ★ J.M.I. ★ STEINER ★ ADLERBLICK ★ 1000 OAKS ★ SWIFT ★ EDMUND ★ NIKON ★ DELTA BRAND ★ EWA ★ TASCO ★ VIXEN ★ LOSMANDY ★ SELSI ★

Black Mountain Astronomy

I WITNESSED THE GREAT COMET CRASH T-SHIRT

JUPITER IMPACT T-SHIRTS By artist Jeni Gill, shirt screened front and back $19.95

METEORITES
WIDE VARIETY OF ASTRO T-SHIRTS
LAMINATED CHARTS
POSTERS
ORION NEBULA WATCH ONLY. $39.95
AND MORE

Send $3.00 for full-color catalog.
Cost refundable on first order.
Phone orders VISA, MASTER 1-800-688-6178
A Division of International Network Enterprises
SEND CHECK OR MONEY ORDER TO:
I.N.E.
4410 W. UNION HILLS DR.7-148
GLENDALE, AZ 85308

HIGH PERFORMANCE AFFORDABLE
ASTRONOMY SOFTWARE

- Planetarium Simulations
- Ephemeris Generators
- Astronomical Databases
- Celestial Mechanics
- High Resolution Images
- Image Processing
- Satellite Tracking
- Graphic Animations
- Many other Astronomy & Scientific Categories

WORLDS LARGEST SELECTION OF AFFORDABLE ASTRONOMY & SCIENTIFIC SOFTWARE

FREE Catalog - Specify IBM or Commodore 64/128
- VISA & Mastercard accepted -

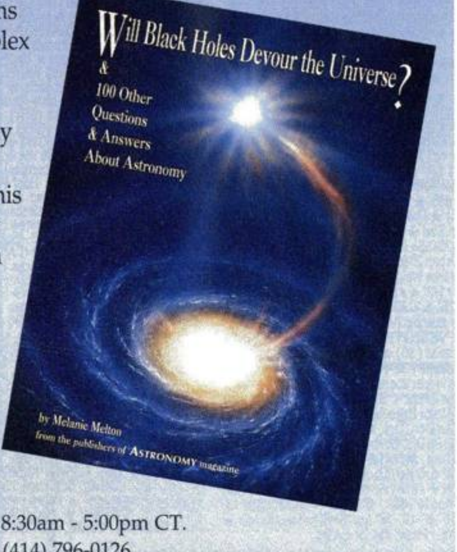
ANDROMEDA SOFTWARE, INC.
P.O. BOX 605-R, AMHERST, NY 14226-0605
FAX: 716-691-6731

Has Shoemaker-Levy left you with questions about our universe?

Will Black Holes Devour the Universe?
& 100 Other Questions & Answers About Astronomy

"Why do stars twinkle? Will the Sun ever burn out? What's the difference between a meteor and a meteorite?" Here astronomer Melanie Melton has collected 101 of these most-asked questions and answered them with explanations that are clear and to the point. Complex questions are addressed in simple, easy-to-understand language and, where needed, are further clarified by helpful illustrations.

Will black holes devour the universe? This charming book satisfies the curiosity within us all—and is a must-have on the shelves of educators, amateur astronomers, their families, and friends. By Melanie Melton.
7¼ x 9¾; 104 pgs.; sftbd.
#18541.................................$14.95


Will Black Holes Devour the Universe?
& 100 Other Questions & Answers About Astronomy
by Melanie Melton
from the publishers of ASTRONOMY magazine

Call toll free 24 hours a day,
1-800-533-6644.
For faster service call Monday - Friday, 8:30am - 5:00pm CT.
Please have your credit card ready. Fax (414) 796-0126.
Outside the U.S. and Canada call (414) 796-8776.

Or use the order form bound in this magazine. Send your order to: **Kalmbach Publishing Co.**, Dept. A0951, 21027 Crossroads Circle, P.O. Box 986, Waukesha, WI 53187-0986. Include for postage and handling: U.S. add $3.00 for 4th class (or $4.50 UPS in the continental U.S. only). Canada add $5.00, other foreign add $10.00. Maryland and Wisconsin residents add 5% sales tax. Virginia residents add 4.5% sales tax to total. Canadian orders add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

Dept. A0951

READER'S EXCHANGE

FOR SALE. Coulter Odyssey 8" (excellent condition), Dob Driver II (still in box) with battery pack and counterweights, Telrad, mounted Mylar solar filter and dust cover, 7x50 Orion Explorer binoculars (with Binoc U-Mount), tripod, eyepieces (6mm, 12mm, and 27mm Kellner), 2x Barlow, accessory case, and filters; asking $900 (would cost over $1,600 new). Contact Robert Henry, 27 Brookside Ave., Newburgh, NY 12550, (914) 562-6266.

FOR SALE. Split-ring equatorial mount, wood construction, 90% completed 17½" mirror, converted Odyssey telescope. $750 or best offer. Contact Tom Slobodian, (517) 739-0785.

WANTED. Owner's instruction handbook (or a copy) for Sans and Streiff Spacemaster #618 Equatorial Refractor telescope. (Coated, D=76mm, F=1200mm, #970406.) Contact Jean TerHorst, 27526 N. Owens Rd., Mundelein, IL 60060, (701) 949-1030.

FOR SALE. Meade 8" f/6 Equatorial Newtonian Telescope with RA motor drive and drive corrector, manual dec slow-motion control, 8x50 polar finder, accessory shelf, wheeley bars; $500 plus shipping. Contact Matt Brady, (808) 423-2263 or (808) 471-9061.

FOR SALE. Meade LH 3 8" SCT. Includes: Tripod and wedge, foam-fitted storage trunk with the following in separate box: hand controller, neutral density Moon filter, Mars filters, LPR filters, right angle, visual back, Meade 25mm, 12.5mm, 7mm and 4mm eyepieces. All knobs, manuals, and power cord. First $1,000 takes it. Eventually purchasing larger scope for my programs. Contact Linda Jacobson, (813) 368-6106. USA.

FOR SALE. *AD ASTRA* Magazine (1989-present, 41 issues). *The Planetary Report* (Jan/Feb. 1986-present, 52+ issues). *Final Frontier* (complete set from Vol.1, No.1-present, 39+ issues). Also ASTRONOMY (1986-1993) complete issues, *Popular Photography* (Apr. 1989-present), *Petersen's Photographic* (Nov. 1989-present). Please make an offer. Need help with college expenses. Contact Tom Dougherty (617) 986-0932.

FOR SALE. JMI manual declination control for Meade 6-8-10" Starfinder mount, $75; JMI Mototrak IV dual axis drive corrector, complete with internal battery pack, $200; Contact Mark Julevich, 530 Grandview Ave. #14, Woonsocket, RI 02895, (401) 767-2265.

FOR SALE. Meade LX-200 10" f/10 with 8,000 object library, superwedge, and complete set of Meade accessories too numerous to list. Instrument just over one yr old, mint condition. $3,500 or best offer. Pick up or buyer pays shipping and handling. Contact Thomas Griffiths, 2813 Hampton St., Ashland, KY 41101, (606) 324-6366.

FOR SALE. Meade 1266 telescope, assorted eyepieces, attachment, and accessories. $4,500. Contact Sam or Jackie Cole, 2819 Orr Ln., Oscoda, MI 48750, (517) 739-9256.

FOR SALE. Celestron C4.5 Newtonian. Barely used. Unused 25mm eyepiece. Quartz drive. Outstanding optics. $525 (I'll pay shipping via UPS.) Contact Jim O'Donnell 20 W. 36th St. #305, Kansas City, MO 64111, (816) 531-4178.

FOR SALE. 10" Meade LX3 with wedge, field tripod, hand controller, photo guide scope, tele-extender, declination motor, illuminated reticle, 5 Plössl eyepieces, case, tripod bag, and more. $1,700. Contact Glenn, Queens, NY, (718) 628-8847.

WANTED. Portable astronomical telescope. Will swap *The Southern Skies* by R.A. Proctor, (1896 Longmans Green and Co.). Loose pages edition of early atlas of the southern skies. Complete book of 20 pages plus the 12 maps. In perfect condition. Write to: Boris A. Fredes, PO Box 131, Mt. Waverly Vic 3149, AUSTRALIA.

WANTED. Slides or 4x6 photos of the May 10, 1994 annular eclipse showing first contact to annularity to end. Contact Tom Parady, Jr., RD 4, Box 527, Meadville, PA 16335, (814) 724-6717.

FOR SALE. Meade 10" f/10 LX 200 SCT with all accessories. One year old, perfect condition; $2,000. Contact Seymour Flattau, (516) 785-3446.

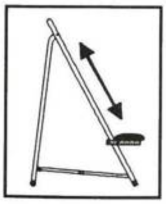
WANTED. Looking for a willing amateur observer in the Sydney, Australia area who would like to assist an eager, intelligent beginner. Contact Gail Clark, 2832 Silverwood Place, Pocatello, ID 83201-2723.

ANNOUNCEMENT. Interested in science, astronomy, medicine, and science fiction frontiers? If so, *Destinations* — a bimonthly newsletter devoted to these topics — is perfect for you. For more information send a SASE to: *Destinations*, PO Box 238, Pultneyville, NY 14538.

FOR SALE. TeleVue Pronto with 2" diagonal, 15mm and 32mm Wide Field, 10.5mm and 21mm Plössl, plus 1.8x Barlow; $800. Contact Chuck (206) 364-5563 (evenings).

FOR SALE. 6" Cosmos RFT. Brand New, only used twice. Cost $400; accepting $375 or best offer. Altazimuth tripod, cost $200; asking $150 or best. 8" Newtonian-Dobsonian, handcrafted oak; $400 or best offer. Contact Mike, (708) 377-6141 (after 5 p.m.).

FOR SALE. Meade 12.5" Newtonian reflector, f/6 optics with 1905 focal length. Includes Lumicon Newtonian easy guider with Pentax adapter, Pentax camera adapter for eyepiece projection planetary photography, dual drives with corrector and eyepiece. System is ready for both observing or astrophotography; $2,800 plus shipping. Contact J.R. Swartz, (210) 520-8964.



Portable OBSERVING CHAIR

Adjustable seat height from 9" to 32"
Chrome or Black finish
$149.00 + shipping

AstroSystems, Inc.
1-303-587-5838

Pocono Mountain Optics 1-800-569-4323
Rex's AstroStuff 501-331-3773

ECLIPSE SHADES™
Solar Viewing Glasses

Custom Imprinting Available!
ECLIPSE SHADES

Safe for direct solar viewing! Eclipse Shades™ provide the ultimate in protection from harmful Solar Radiation. Lenses made of Optical Grade, Neutral Density 5 Mylar, filter out 100% of Ultra-Violet, 100% of Infra-Red, and 99.999% of Visible Light.

Quality Paper Eyewear & Specialty Optics
Rainbow Symphony, Inc.
6860 Canby Ave. #120, Reseda, CA 91335
1-800-821-5122 FAX (818) 708-8470

ASTRONOMY 101

NEW CHILDREN'S VIDEO!

A Real Life Learning Adventure For Children (Ages 5 to 12)

Join Michelle and her mother as they show you how they explore the night sky together.

Learn how they got started and the things they do to learn more about the stars.

Watch exciting animation as Michelle explains all about the telescopes and how and why constellations seem to move across the night sky.

Peer into binoculars and telescopes with Michelle and her mom as they view the moon and planets from their backyard.

Astronomy 101 is the family learning adventure that will open the universe of sky watching to you and your child.

Send check or money order to **Mazon Productions, Inc.,** P.O. Box 2427, Northbrook IL 60065-2427.

VIDEO $19.95
Postage and Handling $3.95

800·332·4344

ODYSSEY TELESCOPES
Seeing the *real* Universe

NEW! ODYSSEY 8" f/7!
BEST BUY AT $239.50!
ADVANTAGES:
- SUPERB LUNAR-PLANETARY VIEWS
- STRONG DOUBLE STAR SPLITTER
- 1/8 WAVE OPTICS, GUARANTEED!
- LOWEST PRICED 8"!
- ALL ODYSSEY 8" f/4.5'S FIT MOUNT!

FREE INFORMATION
- ODYSSEY GUIDE
- OWNER COMMENTS
- FREE TELESCOPE TESTER
- DOBSONIAN INFO.
- COULTER OPTICAL NEWS
- PRODUCT LIST

ASK FOR IT!

8 INCH - $275.00
"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby."
David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years."
Tom Johnston, Boulder, Colo.

10.1 INCH - $345.00
"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)."
Lee Johnson, Coquitlam, B.C. Canada

13.1 INCH - $575.00
"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms any thing that I have seen!!"
Richard Ziegler, Maumee, Ohio
"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides."
Mark Davenport, Pinellas Park, Fla.

17.5 INCH - $1150.00
"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbara, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion."
David Broad, Santa Barbara, Ca.

EASY TO ORDER... Phone or mail your order in today. Visa/MasterCard accepted. All telescopes are shipped freight charges collect. All mirrors are shipped prepaid in the contiguous U.S.A. No sales tax on out-of-state orders. Phone orders Mon.-Fri. 8 am-4:30 pm local time.

Call 1-909-659-4621

• 30 days returnable • 30 days exchangeable
• 2 years materials and workmanship

Coulter Optical, Inc.
P.O. Box K • Idyllwild, CA 92549

"OPTIMUM OPTICS AT MINIMUM COST SINCE 1967"

ASTRONOMY Blue Sky Pages

Your guide to local astronomical dealers

ARIZONA

TUCSON'S COMPLETE ASTRONOMY SHOP

- New and Used Equipment
- Meteorite and Meteorite Jewelry
- Books, Posters, Maps & Star-Charts
- Custom Work-Machine & Wood Shop Work Available
- Observatory Construction & Repair
- Observing site and tour guides available.
- Rental equipment available – call for details.
- Repair Work-Telescope Cleaning & Collimating
- Knowledgeable Professional Staff

Stellar-Vision & Astronomy Shop
1835 S. Alvernon #206
Tucson, AZ 85711
(602) 571-0877

Credit cards accepted. 90 days same as cash.

THE ASTRONOMY SHOPPE

- Telescopes • Spotting Scopes
- Binoculars • Maps • Books
- Eye Pieces & Acces.
- "Bigfoot" Mounts
- Custom Optics

15836 N. Cave Creek Road
Phoenix, AZ 85032
602-971-3170

FLORIDA

SARASOTA CAMERA EXCHANGE & VIDEO CENTER

1055 South Tamiami Trail
Sarasota, Florida 34236

TELESCOPES

Celestron • New Meade • Tele Vue
Large Accessory Inventory • Used Telescopes
Astrosystems • Telescope Components
Astro Software • Jim's Mobile

BINOCULARS

B & L • Bushnell • Celestron • Leica • Meade
Minolta • Nikon • Pentax • Steiner

Microscopes and Accessories

(813) 366-7484 Call or write Chuck, our dedicated astronomer.

GEORGIA

Telescopes • Binoculars
Accessories • Spotting Scopes

Celestron • Leica • Meade
Nikon • Minolta • Pentax

Trade-Ins & Consignments Welcomed

WE SHIP ALMOST ANYWHERE

Camera Bug Ltd.

1799 Briarcliff Rd. • Atlanta, GA 30306
(404) 873-4513 • FAX (404) 873-3925
Hours: 9:00-6:00

NEW HAMPSHIRE

WE BUY USED TELESCOPES

Q: Why buy from RIVERS?

A: Largest in-store display in New England!
: Full line CELESTRON, MEADE, TELE VUE, PARKS, NIKON dealer
: 30-day exchange!
: Inspection of all goods sold!
: Over 60 years in business!
: Accepts "Trade-ins"
: No sales tax!
: Best of all friendly service!

(603) 742-4888 • FAX: (603) 742-5456

Rivers CAMERA SHOP

454 CENTRAL AVENUE
DOVER, NH 03820

NEW MEXICO

NMA NEW MEXICO ASTRONOMICAL

CELESTRON • MEADE • TELE VUE
PARKS OPTICAL • UNITRON • HOME DOME

WE ARE NOW MAIL-ORDER PRIMARILY

NEW SUPER LOW PRICES!

Telescopes • Eyepieces • Mounts • Accessories
Books • Sky Atlases • Observatory Fabrication
On-Site Observatory • Regular Star Parties

INDIVIDUALIZED ADVICE FOR THE SERIOUS AMATEUR

834 N. GABALDON RD • BELEN, NM 87002
(505) 864-2953

NEW YORK

BERGER BROS. CAMERA EXCHANGE

TELESCOPES • BINOCULARS • CAMERAS • CAMCORDERS

Over 45 years in business. Honest Reputation.

BERGER BROTHERS CAMERA & VIDEO EXCHANGE
209 Broadway • Amityville, NY 11701 • **Info:** (516) 264-4160
Orders: 800-262-4160 • **Fax:** (516) 264-1007

NORTH CAROLINA

BALL PHOTO SUPPLY CO.

• Telescopes up to 14" • Spotting Scopes • Binocs - All Makes • Trade-ins Accepted • Lowest Prices • We Ship Anywhere • In-Store Repair Shop

Oldest & Largest Camera Store In The South
85 Tunnel Road • Asheville, NC 28805
(704) 252-2443 FAX (704) 253-1457

OREGON

NURNBERG SCIENTIFIC

6310 S.W. Virginia Ave. • Portland, Oregon 97201

Call Stan, our astronomy enthusiast, for expert personal assistance in choosing a fine Tele Vue, Meade or Celestron telescope and accessories.

We also carry our own full line of microscopes.

(503) 246-8297
Hours: Monday - Friday 8:30 to 4:30

Put your ad in the "Blue" and your business in the black.

ASTRONOMY's "Blue Sky Pages" is cost effective advertising that exposes your business to the world's largest audience of active, amateur astronomers 12 times a year.

Call Erik Bergstrom at 1-800-558-1544, ext. 538 for more information.

ASTRONOMY Blue Sky Pages

Your guide to local astronomical dealers

PENNSYLVANIA

AMATEUR ASTRONOMERS...

THE NEW TELE VUE - GENESIS SDF
SKY TOUR PACKAGES ARE NOW AVAILABLE

SPECIAL PACKAGE INCLUDES:

Genesis SDF, Gibralter Mount, Factory Installed Sky Tour, Star Beam, Air Chair, 7 Nagler, 1.8 Barlow. PLUS Pocono exclusively also gives you a 4.8 Nagler and Thousand Oaks Solar Filter. Call or stop in for details.

- ★ **See Solar Prominences every Saturday with the Genesis SDF/Solar Kit and T-Scanner at our showroom.**
- ★ **Tele Vue Plossls sale priced from $69.00.**

Send SASE for free price list/$6.00 for complete catalog package

✹ We ship everywhere ✹

SEE OUR ADS ON PAGES 18, 93, 101

Pocono Mountain Optics
RR 6 Box 6329
North Pocono Village Shopping Center
Moscow, PA 18444

Orders Only (800) 569-4323
Info. (717) 842-1500 (9am-9pm)
Fax (717) 842-1408 (24 hrs.)

Showroom hrs: 10-5 Mon. – Sat.

SOUTH CAROLINA

Wonder Works

S.C. LARGEST SELECTION OF TELESCOPES:

Spotting scopes, binoculars & opera glasses
Celestron, Meade, Tele Vue & Nikon Dealers
Best prices, selection assistance,
& free instruction.

PHONE ORDERS WELCOME
OPEN 7 DAYS

280 W. Coleman Blvd. • Mt. Pleasant, SC 29464
800-352-2316

WISCONSIN

EAGLE OPTICS

Meade
Dobsonians & Equatorials
in Stock!

Binoculars, Telescopes,
Star Charts & Accessories

Shipping Nationwide

716 S. Whitney Way
Madison, WI 53711 (608) 271-4751
Toll Free Order Line (800) 289-1132

CANADA

Star Gazer Instruments

◊ Telescopes ◊ Binoculars
◊ Accessories ◊ Books
◊ Celestron, Omcon,
1000 Oaks and more!

Canada-wide delivery • (204) 476-3855
Box 1851 • Neepawa, MB CANADA R0J 1H0

1857 **HARRISON**
Serving Canadians
for over 135 years

Telescopes, Binoculars, Microscopes, Magnifiers, Accessories, Books, Meteorological Instruments, Gadgets, T-Shirts and Sweat Shirts

• Celestron • Minolta • Meade • Bushnell •
• Bausch & Lomb • Pentax • Zeiss • Steiner •

Fast Canada-wide Delivery
Will match any advertised Canadian retail price

Montreal
Fax (514) 341-1184 • (514) 341-2079
8425 Mountain Sights Ave. • Montreal, Quebec H4P 2B9

Vancouver
(604) 737-4303
2574 Granville Street • Vancouver, B.C. V6H 3C8

CANADA

Meade APD Telescopes

CANADA-WIDE DELIVERY

Bonus Video "How To Use a Telescope" with telescope purchase ($39.95 value)

FREE! Discount Price List. Call or Write.
(416) 783-4140 FAX: (416) 783-7697

KHAN SCOPE CENTRE
3243 Dufferin Street
Toronto, Ont. CANADA M6A-2T2

CANADA, BC INTERIOR

Full science & nature
at two locations

Natural Heritage Shop
2805 27th Street, Dept. A3
Vernon, B.C. V1T 4W3

SIRIUS
Science & Nature
Orchard Park Centre, Kelowna B.C.

Family Owned and Operated
Best Prices, Excellent Service

Celestron, Meade,
Tele Vue, Omcon, Kowa,
Bausch & Lomb, Zeiss

CANADA-WIDE DELIVERY
Phone (604) 542-4367
Fax (604) 542-1986

The sky's the limit when you advertise in the..."Blue Sky Pages."

A regular advertising schedule in the "Blue Sky Pages" will attract attention to your business. Your store's name will be directly in front of the world's largest audience of active, affluent amateur astronomers. Call Erik Bergstrom at 1-800-558-1544, ext. 538 for information.

One of the country's oldest telescope stores has the World's newest equipment!

Telescopes • Binoculars • Accessories
Trade-Ins • Used Equipment • Repairs

Established in 1916!

Celestron

C5⁺ Package (includes case & aluminum tripod)....................$1,500

C90 1-1/4" with camera adapter.............$500
NEW! 12x80 Giant binoculars.................$440
NEW! 20x80 Giant binoculars.................$460

Tele Vue

Genesis-sdf...$1,850
Pronto with 2" diagonal..........................$800
Pronto with 1-1/4" diagonal...................$715
All eyepieces and accessories in stock.

QUESTAR
We are a Questar dealer and offer discounts on the entire line of Questar telescopes and accessories.

Meade
We are a dealer of all Meade products including LX200's, the new Pictor CCD cameras, the ED APO refractors, and all eyepieces and accessories.

Miyauchi
20x100 binoculars.............................$2,175

Astropix (NEW Windows Version!)
Exposure guidance software....................$40

F. C. Meichsner Co., Inc.
182 Lincoln Street, Boston, MA 02111
1-800-321-VIEW!
Tel: 1-800-321-8439 Fax: 617-426-0837
Accessible Boston showroom
Phone and mail orders welcome
Call for price list

Prices subject to change without notice.

RESOURCES & PHOTOFACTS

Two by Two (page 30)

Asteroids II, edited by R. Binzel, T. Gehrels, and M. Matthews, (University of Arizona Press, 1989). The definitive scientific work dealing with the study of asteroids.

Journey to the Sun (page 38)

"Heating the Sun's Million Degree Corona" by Leon Golub, ASTRONOMY, May 1993. Describes how energy flows from our star's surface into its tenous outer atmosphere.

Mountains of Io (page 46)

"The Violent Volcanos of Io," by Richard Talcott, May 1993. A look at how planetary scientists are keeping tabs on Io's volcanism using telescopes on the ground and in space.

Mars (page 72)

Observing and Photographing the Solar System by Thomas Dobbins, Donald Parker, and Charles Capen, (Willmann-Bell, 1988). Provides an overview of planetary observing and photography techniques.

Sea of Serenity (page 76)

Atlas of the Moon by Antonín Rükl, (Kalmbach, 1992). A beautiful and detailed lunar atlas by a master cartographer; essential for Moon observers.

The Geologic History of the Moon by Don E. Wilhelms, (U.S. Geological Survey Professional Paper 1348, 1987). Best current survey of lunar geological history; profusely illustrated.

Build a PortaScope (page 80)

Telescope Optics by Harrie Rutten and Martin van Venrooij, (Willmann-Bell, 1988). Explains in detail how to completely baffle a Newtonian tube if you wish to extend the partial baffling of the PortaScope.

"Improving Your Mount" by Thomas McGraw, ASTRONOMY, December 1994. Shows how to make setting circles for a Dobsonian.

---

p. 54: Donald C. Parker; **p. 59:** Gert Kroner; **p. 60:** Henry Nebel; **p. 61:** U.S. Naval Observatory; **p. 62:** Donald G. Bruns; **p. 63:** Abdul Hadi Marafie; **pp. 66-67:** Jason Ware, 6-inch apochromatic refractor, composite of two 60-minute exposures; **p. 67, top:** David Higgins; **bottom:** George Greaney, 6-inch f/7.1 apochromatic refractor, hypersensitized Fuji Super HG 400 film, composite of two 50-minute exposures; **p. 68, left:** Gerald Rhemann, 6.7-inch f/1.5 Schmidt camera, Fuji Super HG 400 film; **top:** Martin C. Germano, 8-inch SCT at f/10, hypersensitized Tech Pan film, 20-minute exposure; **p. 69, top left:** Jack Marling, 17.5-inch f/4.5 reflector, Fujichrome 400 film, 40-minute exposure taken with a Deep-Sky filter; **top right:** Bill and Sally Fletcher, 8-inch f/4.5 reflector, hypersensitized Tech Pan film, tricolor exposure using 60-minute (red), 15-minute (green), and 115-minute exposure; **bottom:** Luke Dodd, 4.7-inch f/8.5 apochromatic refractor, hypersensitized Fuji Super HG 400 film, 60-minute exposure; **p. 70, top left:** James R. Foster, 11-inch SCT at f/11, hypersensitized Tech Pan film, 210-minute exposure; **top right:** Martin C. Germano, 14.5-inch f/5 reflector, hypersensitized Tech Pan film, 70-minute exposure; **bottom:** Martin C. Germano, 8-inch f/5 reflector, hypersensitized Tech Pan film, **p. 71, top left:** Jack Newton, 20-inch f/5 reflector, 20-minute exposure; **top right:** Preston Scott Justis, 10-inch f/6 reflector, hypersensitized Tech Pan film, 90-minute exposure; **p. 72:** Donald Parker, 16-inch f/5 reflector working at f/48 and Spectra Source Lynxx CCD camera; **pp. 72-75:** Drawings made during Mars' 1992-93 apparition by Dan Troiani using 12.5", 16", 17.5, and 20" Newtonian telescopes. Drawing projections done through a mapping program developed by Richard Berry; **p. 76:** Jean Dragesco, 7-inch refractor, Kodachrome 25, 1-second exposure at f/18 on May 21, 1991; **p. 109, top:** William McLaughlin and Dennis Luse, 8-inch SCT at f/6, ST-5 CCD camera, 60-second exposure on August 12, 1994; **middle and bottom:** Keith Snyder, Steve Messner, Bob Elliott, and Paul Nelson, 12-inch reflector, STAR-I CCD camera, 160-second exposure in July 1994; **p. 110, top:** Sam Bissette, 50mm lens; inset is a 50x enlargement photographed through a microscope; **middle:** John Blankinship, 40mm lens at f/4, 8-minute exposure taken on August 12, 1994; **bottom:** Kim Zussman, 14.5-inch f/8 Cassegrain, hypersensitized Tech Pan film, 190-minute exposure; **p. 111, top:** George Greaney and Mike Newton, 14-inch SCT at f/7, hypersensitized Fuji Super HG 400 film, composite of two 55-minute exposures printed onto Vericolor print film; **bottom:** Luke Dodd, 105mm lens at f/3, hypersensitized Fujicolor 400 film, composite of two 20-minute exposures; **p. 112:** Kent Wood, 150mm lens at f/22, thirteen 1/4-second exposures at 15-minute intervals on May 10, 1994, taken from Tucson, Arizona, foreground photo was a 1/15-second exposure at f/32

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Required by 39 U.S.C. 3685)

1A. Title of publication: ASTRONOMY. **1B. Publication No.:** 531350.

2. Date of filing: September 20, 1994.

3. Frequency of issue: Monthly. **3A. Number of issues published annually:** 12. **3B.** Annual subscription price: $27.00.

4. Complete mailing address of known office of publication: 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-9951.

5. Complete mailing address of the headquarters of general busienss offices of the publisher: 21027 Crossroads Circle, Waukesha, WI 53187-9951.

6. Full names and mailing addresses of publisher, editor, and manager editor: Publisher, Russell G. Larson, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-9951; Editor, Robert Burnham, same address; Managing Editor, Rhoda I. Sherwood, same address.

7. Owner: Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-9951; stockholders owning or holding 1 percent or more of total amount of stocks are Ruth H.O. Darragh, Route 8, Box 95, Harrison AR 72601; Harold Edmonson, 6021 N. Marmora Ave., Chicago IL 60646; George A. Gloff, 9995 W. North Ave., Wauwatosa WI 53226; Elizabeth K. Grunden, 10926 Leaning Ash Ln., Houston TX 77079; Linda H. Hanson, 22154 Harbor Rd., Barrington IL 60010; Robert L. Hayden, Jr., P.O. Box 1612, Waukesha WI 53187; Dr. H. W. Hein, 2549 S. Kinnickinnic Ave., Milwaukee WI 53207; George F. Hirschmann Trust, 635 Glenridge Dr., Glenview IL 60025; Margaret Jenkins, 2434 N. 102 St., Wauwatosa WI 53226; Charles A. Kalmbach, 7435 N. Braeburn Ln., Glendale WI 53209; Lois P. Kalmbach, 7435 N. Braeburn Ln., Glendale WI 53209; Kalmbach Profit Sharing/401K Savings Plan & Trust, P.O. Box 1612, Waukesha WI 53187; James. J. King, 3874 Quail Ridge Dr., Boynton Beach FL 33436; Mahnke Family Trust, 10006 LaPlacita Dr., Rancho Cordova CA 95670; Walter J. Mundschau, P.O. Box 1612, Waukesha WI 53187; Robclif Inc., P.O. Box 3597, Reno NV 89505; David M. Thornburgh Trust, 420 W. San Marino Dr., Miami Beach, FL 33139-1136.

8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities: Not applicable.

9. For completion by nonprofit organization authorized to mail at special rates (Section 423.12 DMM only):

10. Extent and nature of circulation. 10A. Total number of copies printed (net press run): average number of copies each issue during preceding 12 months: 231,880; actual number of copies of single issue published nearest to filing date: 232,732. **10B.** Paid and/or requested circulation: **10B1.** Sales through dealers and carriers, street vendors and counter sales: 55,589; actual number of copies of single issues published nearest to filing date: 55,500. **10B2.** Mail subscription (paid and/or requested): 113,336; actual number of copies of single issues published nearest to filing date: 113,279. **10C.** Total paid and/or requested circulation (sum of 10B1 and 10B2): 168,925; actual number of copies of single issues published nearest to filing date: 168,779. **10D.** Free distribution by mail, carrier, or other means, samples, complimentary, and other free copies: 1,425; actual number of copies of single issues published nearest to filing date: 903. **10E.** Total distribution (sum of C and D): 170,349; actual number of copies of single issues published nearest to filing date: 169,682. **10F.** Copies not distributed: **10F1.** Office use, left over, unaccounted, spoiled after printing: 1,743; actual number of copies of single issues published nearest to filing date: 2,396. **10F2.** Return from news agents: 59,788; actual number of copies of single issues published nearest to filing date: 60,654. **10G.** Total (sum of E, F1, and F2 — should equal net press run shown in A): 231,880; actual number of copies of single issues published nearest to filing date: 232,732.

11. I certify that the statements made by me above are correct and complete. Daniel Lance, Vice President — Sales & Marketing.

Still time for Holiday Delivery!

Last Chance to Save on These Select Meade Accessories!

911B Nebula Filter	$90	56mm Super Plossl *and* #929 Diagonal; both for only	$230
911N Nebula Filter	100	#62 Camera Adapter	23
f:6.3 Focal Reducer	115	#929 2-inch Diagonal	90
Tele Extender	27	40mm Plossl 1.25"	70
Variable Tele Extender	36		

Shutan Stocks Almost Every Meade Telescope!

New! Meade Pictor Series CCD Autoguiders and Imagers from $395

Send $3 for full-line 1995 Meade Catalog!

NEW!

Meade Series 3000 Plossl Eyepieces:
5, 6.7, 9.5, 16, or 25mm
- Made in Japan
- Multi-coated
- 4-element!

$60 each
Any 2 for $53 ea.
Any 3 for $49 ea.

40mm S3000 Plossl in stock for only $70

Meade Barlows:		**Misc. Meade**		Filter set of 4	$55	Off-axis guider	$80
#122 2x 1.25"	$48	Accy case 50	$67	Filter set of 8	99	Piggy bracket	32
#127 2-3x 1.25"	60	Car cord LX200	85	Filter set of 12	145	Polar finder 814	95
#134 2x .96"	40	Diagonal 1.25"	42	Filter ND96 1.25"	18	Skylight/seal	48
#140 2x 1.25"	80	Diagonal .96-1.25"	28	IBM software-200	100	Tele extender	Sale
2045 Accy's:		Diagonal .96" 45°	53	Illum 12mm w/cord	80	Tele ext-variable	Sale
Barlow 126 2x	48	Diagonal 1.25" 45°	53	Illum 12mm-wless	100	T-adapt: SC	Sale
Car cord	20	Diagonal 929 2"	Sale	Illum 9mm w/cord	130	T-adapt: vari-proj	40
Carrying case	80	EP holder 1.25"	25	Illum 9mm-wless	150	T-adapt: .96"	30
Tripod & wedge	265	Focuser 70 1.25"	49	Lenshood 8"	114	T-adapt: 1.25"	30
Starfinder Accy's:		Focuser 680 2"	100	Lenshood 10"	124	T-rings	16
Dust caps	call	Focuser 682 2"	100	Nebula 908B	80	Vari pol 905	50
Dec 55	78	Finder brkt-8x50	25	Nebula 908N	90	Weight set 8"	85
Drive 43 110v-12v	129	Finder 544-8x50	70	Nebula 911B	Sale	Weight set 10"	90
Drive 47M (6-8-10)	429	Finder 545-8x50	70	Nebula 911N	Sale	Wedge 8"	134
Drive 48RS (16")	499	Finder 634-6x30	50	Object libraries	call	Wedge 10" Super	395

Meade Series 4000 Eyepieces:

Super Plossl 6.4, 9.7, 12.4, 15, 20, 26	$88
SP32 or 40mm	110
SP56mm	Sale
Super Wide 13.8	160
Super Wide 18	170
Super Wide 24.5	199
Super Wide 32	280
Super Wide 40	340
Ultra Wide 4.7	180
Ultra Wide 6.7	220
Ultra Wide 8.8	270
Ultra Wide 14	330

Ask about our Special $10 UPS AIR Accessory Delivery!

Jim's Mobile
Moves in-out
Zero-Image-Shift Electric Focus!
*Fits **ALL** Meade and Celestron SCT's!*
$189 1.25"
2-inch NGF-S $269

LX200 Keypad Holder
$32

Leveling Wheels!
Fits any Meade
*8"/10" SCT, 4"/5" APO, **and** Starfinder 6"/8"/10"*
$138

Telrad
Call

TeleVue

		Ext tube	$33	**Plossl:**		**Panoptic:**	
		CXD-1 motor	234	7.4, 10.5, or 13	$ 68	15mm	$195
Genesis SDF	Call	Polar finder	119	17, 21, or 26	68	22mm	245
Pronto	Call	Air Chair	119	32 or 40mm	99	27mm	295
Renaissance	Call	**Nagler:**		55mm	219	35mm	320
Panoramic mt	349	4.8mm	145	**Wide Field:**		Barlow interface	94
Gibraltar mt	449	7mm	184	15mm	130		
Starbeam-T	179	9mm	215	19mm	140	**Barlows:**	
Cam. adapter	39	12mm Type2	245	32mm	234	1.8x	79
Piggycam	45	16mm Type2	284	**Paracorr 1.25"**	139	2.5x	79
Eyepiece proj	69	20mm Type2	335	**Paracorr 2"**	214	Big Barlow 2"	150

Sale!
Foam Lined Accessory Case!
Large! 13x19x7" $50

Celestron

		MFFT-55	$159
		Piggy brkt. 8"	32
		Radial guider	124
Ultima 2000	Call	Tele ext. Deluxe	45
C5+ w/wedge	Call	Ultima 2x 1.25"	79
C5 tripod	259	Lanthanum EP	Call
C5 fitted case	137		
C5 dec motor	95		
C5 lenshood	49		
C5 piggyback	63		
Dew shield-8"	29		
F:6.3 reducer	125		

NEW! Only $329
Al-Azimuth wood field tripod with slo-motion controls. Has 1/4-20 mount for all spotting scopes!

1000 Oaks Solar Filters

4" full-aperture	$ 70
5" full-aperture	90
8" full-aperture	115
10" full-aperture	129

Other sizes in stock!

Precision polished glass, triple-coated in machined aluminum cell. Image is yellow-orange— no need for secondary filtering!

Konica
ASA 3200 Color Print
4-24 exp. rolls $27

1995 Discount Buying Guide Available!

NO CREDIT CARD SURCHARGE! Shutan is family owned **AND** operated since 1918! Order by **NOON** for same-day shipment. Don't be **FOOLED** by other stores with tons of fine print in their ad! We ship most acc'y orders UPS Ground for just **$4.50.** Call for $10 UPS AIR info. Call for telescope prices & stock status. *Prices subject to change.*

Call Us Toll-Free 800-621-2248 • Ilinois 312-332-2000

SHUTAN
camera & video

312 W. Randolph • Chicago • 60606
M-F 8:30-5:30 • Saturday 9-5

VISA MasterCard DISCOVER AMERICAN EXPRESS

ADORAMA INC.

42 WEST 18th STREET • NEW YORK, NY 10011
CUSTOMER RELATIONS • 212-741-0466 • Mon–Thur. 9–4:30, Sun. 11-2 ET

POPULAR PHOTOGRAPHY CHECKRATED STORE

12

FAX #
212/ 463-7223

PHONE ORDERS ACCEPTED
DAY OR NIGHT
MON–THURS. 9 TILL 9:30 PM EST
FRI. 9-1:45 • SUNDAY 9:30–6

STORE HOURS:
MON.–THURS. 9–7pm
FRI TO 1:45 • SUN 9:30–5:45

ORDER TOLL FREE • US & CANADA
800-223-2500
ORDERS & INFO
212-741-0052

COMPLETE with MANUFACTURER'S ACCESSORIES

Visit... the greatest telescope display in the Eastern United States

See... our display of the latest design in **computerized** telescope technology of Meade, Celestron, Edmund Scientific, Tele-Vue, Bushnell telescopes and a full line of accessories

Talk... to knowledgeable *telescope sales staff*, who are glad to guide you to a wise purchase.

Meade®

THE LEADER'S EDGE

We Carry The Complete Line

We are one of the largest Meade stocking dealers on the East Coast with the full line of **Meade** on display

Before you make your purchase, call us for our low prices and don't forget to visit our large display of Telescopes. There you can see all the latest wonders from **Meade**

MEADE EYEPIECES Series 4000

Super Plossl		Ultra Wide		Super Wide	
6.4,9.7,12.4,15mm	Call	4.7mm	Call	13.8mm	Call
20, 26mm	Call	6.7mm	Call	18mm	Call
32mm	Call	8.8mm (1.25"/2")	Call	24.5mm	Call
40mm	Call	14mm (1.25"/2")	Call	32mm (2")	Call
56mm (2")	Call	Barlow 2X Ser 4000	Call	40mm (2")	Call

Series 3000 Plossls .... **Call**

MEADE TELESCOPE ACCESSORIES

Accs. Case #50	**59.95**	#908N Nebular	**Call**
Barlow 2X 1.25" #122	**Call**	#911N Nebular	**Call**
Barlow 2X,3X 1.25 #127	**Call**	**8000 Object Library LX200**	**49.95**
2" Star Diagonal #929	**Call**	Electric Focuser #1207	**134.95**
Off Axis Guider	**Call**	Electric Focuser 1206/1205	**139.95**
12mm Illum Reticle w/wire	**Call**	Dew Shield 8"	**103.95**
12mm Illum Reticle wireless	**Call**	Dew Shield 10"	**114.95**
9mm Illum Reticle w/wire	**Call**	Dew Shield 12"	**174.95**
9mm Illum Reticle wireless	**Call**	Piggy Bk Brkt 2080/2120	**29.95**
45° Erect .96"	**44.95**	Counterweight Syst. 8"	**84.95**
45° Erect Diag. 1.25"	**47.95**	Counterweight Syst. 10"	**89.95**
45° Erect Diag. Hybrid	**39.95**	Counterweight Syst. 12"	**99.95**
Diag. Porro Prism 1.25"	**54.95**	Tele Extender	**Call**
Photo Visual Filt Set 4 pc.	**Call**	Tele Extender Variable	**Call**
#1A Sky Filter	**44.95**	6x30 Viewfinder	**Call**
#908B Nebular Filter	**Call**	8x50 Viewfinder	**Call**
#911B Nebular Filter	**Call**		

Meade Reflectors / Refractors

4.5 Reflector. w/Equatorial Mount	**Call**
60mm Altazimuth Refractor	**Call**
60mm Equatorial Refractor	**Call**
90mm Altazimuth Refractor	**Call**
90mm Equatorial Refractor	**Call**
Basic Camera Adapter 1 1/4"	**29.95**
Variable Projection Camera Adapter 1 1/4"	**39.95**
JMI AC Motor Drive for 395/285/4500	**79.95**
Meade DC Drive for 395/285/4500	**99.95**

SPOTTING SCOPES

2045S Spotting Scope	**Call**	Case for 2045S	**44.95**
97ER	**Call**		

Celestron

5" compact scope
C5 1250 F/10 Schmidt Cassegrain with Starbright coating.
Available in 3 versions:

C5 Telescope w/AC Drive	**Call**
C5+Telescope w/DC Drive	**Call**
C5 Spotting Scope	**Call**
C5 Tripod	**239.95**
Radial Guider C5	**119.95**
DEC Motor C5	**99.95**
JMI Focus Motor C5	**109.95**
Carry Case for C5/C5+	**139.95**
Piggyback Counterpoise C5	**64.95**
Advanced Astro Master f/C5	**549.95**

Celestron Reducer/Corrector f/6.3

This combination focal reducer and field corrector lens accessory works with all Celestron and Meade Schmidt Cassegrains. Now it is possible to have a dual focal ratio instrument without sacrificing image quality. The Reducer/ Corrector is f/6.3 for C8 and C11, f/7 for C14. A four element, fully multi-coated accessory. Results are amazing BOTH visually and photographically.

114^{95}

New CCD AUTOGUIDERS

Adorama has entered the CCD Imaging field. You can now get the latest in CCD at Adorama's renowned most competitive pricing *CALL*

BAUSCH & LOMB BUSHNELL

DISCOVERER

DISCOVERER with 15-60x Zoom	**176^{95}**
Discoverer Case	**44.95**
Tamrac Case for Discoverer	**14.95**
Camera Mount	**18.95**
Car Window Mount	**34.95**

ELITE PC

611548PC #ELITE with Zoom E.P.	**Call**

NEW PREMIER

Premier HDR 15-45 x 60	**Call**

SPACEMASTER (60mm)

Spacemaster	**147.95**
New **Spacemaster ED**	**294.95**
Spacemaster Rubber Armored	**161.95**
Spacemaster with 15-45x, Table Tripod & Case	**243.95**
Spacemaster Rubber with 15-45x Table Tripod & Case	**256.95**

SPACEMASTER ACCESS.

15, 20, 25, 40 & 60x EP	**33.95**
22x Wide Angle	**48.95**
15-45x Zoom Eye Piece	**81.95**
Camera Mount	**29.95**
Baush & Lomb Elite 77mm Spotting Scope	**Call**
77mm S. S. Elite	**Call**

Tele Vue®

NEW PLOSSL

55mm 2"	**Call**
40, 32mm 1 1/4"	**Call**
26, 21, 17, 13mm 1 1/4"	**Call**
10.5, 7.4mm, 1 1/4"	**Call**

NEW PANOPTIC

New 15mm 1 1/4"	**Call**
New 27mm 1 1/4"	**Call**
22mm 1¼"	**Call**
35mm 2"	**Call**
Panoptic Barlow Interface 2"	**Call**

BARLOW

2.5X, 1.8X 1 1/4"	**Call**
Big Barlow 2x 2"	**Call**

NAGLER

20mm Type 2; 2"	**Call**
16mm Type 2; 2, 1 1/4"	**Call**
12mm Type 2; 2, 1 1/4"	**Call**
13mm 2" & 1 1/4"	**Call**
9mm 2" & 1 1/4"	**Call**
7mm 1 1/4"	**Call**
4.8mm 1 1/4"	**Call**

ACCESSORIES

2" Star Diagonal	**Call**
Rich Field Kit w/New 55 Plossl 2" S.D., Adapt, 2" to 1 1/4" Adapt	**329.95**
1¼" E.P. Adt. f/Questar	**59.95**

PARACORR COMA CORRECTORS

1 1/4"	**Call**
2"	**Call**

TELE VUE REFRACTORS

Genesis™-sdf

GENESIS SDF Fluorite-APO	**Call**
GENESIS Fluorite	**Call**
GENESIS-SDF Outfit w/Sky Tour Computer & Gibraltar Mt.	**Call**

PRONTO 70mm Aperture f/6.4 w/ED Glass

PRONTO w/2" star diagonal & 21mm Plossl	**Call**
PRONTO w/1.25" erect prism & 21mm Plossl	**Call**
PRONTO w/1.25" Star Diagonal & 21mm Plossl	**Call**

MOUNTS & ACCESSORIES FOR TELE VUE REFRACTORS

New SKY TOUR Computer–Call for details

GIBRALTAR MOUNT .... **434^{95}**

Gibraltar Mount with Sky Tour Computer	**Call**
Starbeam ."Red Star" Projection Finder	**Call**
Piggy-Cam .Camera Adapter	**41.95**

CELESTRON TELESCOPE ACCS.

AC Adpt. C5+, C8+ Ultima	**27.95**	Polarizer Set 1 1/4"	**46.95**
Car Bat. Adpt. C5+,C8+ Ultima	**27.95**	Series 6 Filter Set	**69.95**
Accs Cs	**44.95**	Stereo Binocular Viewer	**449.95**
Barlow 1 1/4" 2x MC	**54.95**	Star Diag 1.25" MC	**47.95**
Counterweight Bar Assembly 8" **64.95** 11"	**64.95**	**New** Improved 2" Mirror Star Diagonal w/1.25" Adapt.	**124.95**
Case for C8	**179.95**	**Great Polaris 8" Mount with Polaris Finder**	**749.95**
DC Inverter	**89.95**	Sky Filter #2	**39.95**
Diagonal Erect 1.25"	**41.95**	Adj. Tripod Rubberized	**264.95**
Dewstar/Shade 8"	**26.95**	Camera Adapt. Tele Extender .96"	**19.95**
Dual Axis Drive SP/GP	**259.95**	Tele Extender	**24.95**
7x50 Finder Scope with Illuminator & Bracket	**159.95**	Tele Extender Deluxe	**43.95**
Quick Release f/7x50 find	**47.95**	T. Adapter f/Schmidt Cassegrains	**24.95**
LED Flashlight	**16.95**	Vibration Suppression Pads	**39.95**
LPR A **54.95** LPR B	**79.95**		
LPR for Radial Guider	**99.95**		
Piggyback Mt 8"	**34.95**		
Piggyback Bar Assembly 11"	**64.95**		

CELESTRON MYLAR SOLAR SCREEN FILTERS (MOUNTED)

f/C11 (5" O.A.)	**119.95**	f/C90s	**64.95**	f/C5/C5+	**79.95**
f/C4.5	**69.95**	f/C90RC GPC102	**69.95**	f/C8's	**99.95**

CELESTRON 1¼" EYEPIECES

Deluxe zoom Ocular 6.5-18mm Ortho	**119.95**

ULTIMA EYEPIECES

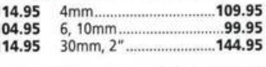
5mm, 18mm, 1 1/4"	**79.95**	7.5, 12.5mm, 1 1/4"	**73.95**		
24mm, 1 1/4"	**79.95**	30mm, 1 1/4"	**92.95**	35m 1¼"	**119.95**
42m 1¼"	**109.95**				

Ultima 2X Barlow Short Tube Version)	**64.95**

New PLOSSL EYEPIECES

7.5, 10, 17, 26mm, 1 1/4"	**49.95**	40mm, 1 1/4"	**59.95**

Vixen Lanthanum Eyepieces LV Series

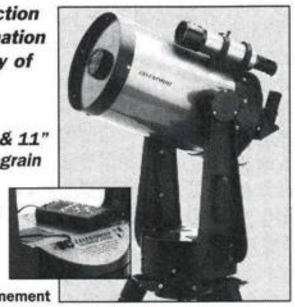


2.5mm,	**114.95**	4mm	**109.95**
5, 9, 15mm, 1.25"	**104.95**	6, 10mm	**99.95**
20, 25mm, 1.25"	**114.95**	30mm, 2"	**144.95**

CELESTRON®

Adorama Proudly Presents...

The Celestron Ultima 2000



Your introduction to the Information Superhighway of the Stars

Computer Automated 8" & 11" Schmidt-Cassegrain Telescopes

The Ultimate in Simplicity & User Friendliness

Just find two alignement stars with the finderscope and let the fun begin

• 10º per second fast slewing speed • 4 Speeds • Ultra smooth and extremely quiet motor • Database of over 10,000 objects • Sky tour feature • RS-232 Port for computer connectivity • Extremly portable.

New Ultima 2000 8"	**2495.00**
New Ultima 2000 11"	**3695.00**
Ultima Deluxe Wedge	**379.95**
Ultima Economy Wedge	**229.95**

• •

SCHMIDT CASSEGRAIN TELESCOPES

CG-11 Telescope	**Call**
G-11 Mount only	**1599.95**
Ultima 8 P.E.C.	**Call**
Powerstar 8 P.E.C.	**1399.95**
New C8+ Telescope	**Call**
New C8+ Computerized Telescope	**Call**
JMI DEC Motor C8+ / Classic 8	**74.95**
JMI Focus Motor C8+ / Classic 8	**79.95**
CLASSIC 8 with Star Bright Coating Outfit w/Wedge	**859.95**
DEC Motor for Classic	**89.95**
8" f/10 Schmidt Cassegrain Optical Tube Assembly with Star Bright Coating, 6x30 Finder, 26mm 1.25" Star Diagonal 1.25", Footlocker Case	**Call**

ADVANCED ASTRO MASTER

New Advanced Astro Master f/fork mounted C8s	**499.95**
for SP Mounts	**459.95**
for GP Mounts/GII	**549.95**

COMA CORRECTOR

With 1¼", 2" Eyepiece & Focus Adapter	**149.95**

RADIAL GUIDER

Allows free movement of guider while camera is fixed	**114.95**
Multi Function Focal Tester 55 Focus on & off the optical axis at 3,16,22 & 30mm Diam. in a single setup......only	**134.95**
Milro Guide Eyepiece	**159.95**

Alt Azimuth Mount w/Slow motion Control ***269.95***

REFLECTOR TELESCOPES

New GP-200 7.9" f/4 Reflector	**1349.95**
C4.5" Newtonian	**Call**
New Firstscope 114 4.5" Newtonian Telescope	**Call**
Motor Drive f/C4.5 Comet Catcher	**169.95**
Tele Extender Refractor/Newtonian	**59.95**

REFRACTOR TELESCOPES

Great Polaris C102 102mm	**Call**
New Great Polaris C102 ED	**Call**
Firstscope 80 w/45 Erect Prism	**Call**
T Adapter Refractor/C4.5	**44.95**
C60 Altazimutzh	**169.00**
New Firstscope 60	**109.00**
60mm Equatorial	**Call**
Image Erector f/60mm Ref	**9.95**

SPOTTING SCOPES

All the C90s Include: 8x20 Erect Image Finder, 45° Erect Image Diagonal, 30mm, .96" E.P., Foam Fitted Case

C90 .... **Call** **C90 MC**	**Call**
C90MC w/1.25" Accs.	**Call**
C90MCRC w/1.25" Accs.	**Call**
New S-80 1.25" Spotting Scope	**Call**
New S-80+ 1.25" Spotting Scope	**Call**
500 f/5.6 Telephoto	**279.95**
f/4 Adapter for 500/5.6	**74.95**
20X 60mm ED Scope	only **199.95**

CELESTRON C90 & SPOTTING SCOPE ACCS.

New Barlow .96, 2x M/C	**44.95**	Star Diagonal .96	**29.95**
7.5, 10, 17, 26 Plossl .96	**47.95**	Diag Prism 45° .96	**46.95**
9mm Ortho, .96	**34.95**	1.25" Diag Prism 45° .for C90	**39.95**
10, 18, 25, 30, 40 Klnr.96	**32.95**	Series 5 Filter Set	**49.95**
Lens Shade C90	**54.95**	Shoulder Mount	**69.95**
Polarizer Set .96	**32.95**		

Edmund Scientific **Astroscan 2001** **299^{95}**

WE SHIP PROMPTLY. ALL TELESCOPES INCLUDE U.S.A. WARRANTY
No Surcharge for MasterCharge or VISA Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or driver's license for reference. Shipping, handling and insurance additional. 14-day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealer's license #802862. Pictures are for illustration purposes only and may not be exact. **Prices effective till Dec. 20, 1994** **Please address all inquiries and orders to ASTRO DEPT. #55**

ADORAMA

42 West 18th Street • New York, NY 10011

ORDER TOLL FREE **800-223-2500**

ORDERS & INFO **212-741-0052**

FAX # 212-463-7223

TELESCOPE ACCESSORIES

LUMICON

UHC PREMIUM FILTERS		DEEP SKY PREMIUM FILTERS			
1 1/4"	**99.50**	.96"	**59.50**	1 1/4"	**79.50**
48mm f/most 2" EP	**199.95**	2"	**119.50**	48mm	**119.50**

FILTER SET 1.25" (UHC with Deep Sky) **159.50**

H-BETA				OXYGEN III			
1¼"	**99.50**	48mm	**199.50**	1¼"	**99.50**	48mm	**199.50**

JIM'S MOBILE

DEC. MOTOR/NGC Computers		FOCUS MOTOR	
f/Meade LX3/5/6/MTS	**69.95**	f/Meade LX5/6	**74.95**
DSC-Max	**488.**	f/Meade LX200	**79.95**
NGC Micro Max	**439.**	**NEW MOTOR TRACK V**	
NGC Mini Max	**549.**	Motor Track V	**Call**
NGC-Max	**749.00**		

FOCUSERS

NGF-1	**209.**	NGF-2	**159.**	NGF-3	**135.**
NGF-4	**109.**	NGF-S	**279.**		

NEW 1.25" NGF FOCUSERS

NGF-1 Mini	**151.95**	NGF-2 Mini	**114.95**	NGF-S Mini	**184.95**

TELRAD

Finder w/Mounting Base	**41.95**	Spare Mounting Base	**7.95**
Dew Shield for Telrad	**11.95**	Pulsar Unit	**19.95**

MEADE PARABOLIC MIRRORS

6" f/8	**139.95**	8" f/6	**194.95**	10" f/4.5	**399.95**
6" f/5	**139.95**	10" f/6	**389.95**		

MEADE ELLIPTICAL FLAT SECONDARY MIRRORS

1.3"	**26.95**	1.83"	**37.95**	2.6"	**53.95**
1.52"	**35.95**	2.14"	**45.95**	3.1"	**84.95**

MEADE RACK & PINION FOCUSER

#67 1 1/4"	**58.**	#680 2"/1.25"	**89.95**	#682 2"	**99.**

beattie **BEATTIE INTERSCREEN PLUS** (4x Brighter)

f/Nikon F, F2, F3, F4	**89.95**	f/Olympus OM1,2,3,4	**62.95**
f/Nikon FE/FE2/FM/FM2/FA	**58.95**	f/Nikon N90	**66.95**
f/Canon EOS	**63.95**	f/Nikon 8008	**62.95**

ASTRONOMY BOOKS

BOOKS FOR BEGINNERS

Astronomy for the Beginners by Patrick Moore	12.95

BINOCULAR OBSERVING

How to Choose a Binocular	4.95
Binocular Astronomy	24.95
Touring the Universe Through Binoculars	29.95
Exploring the Night Sky with Binoculars	4.95

STAR ATLASES

Sky Atlas 2000 Deluxe Edition *by Wil Tirion*	39.95
Sky Atlas 2000 Field Ed.	18.95
Laminated Sky Atlas 2000 Field Edition	59.95
Sky Catalogue 2000. Vol. 1– 2nd Ed. (paperback)	34.95
Sky Catalogue 2000. Vol. 2– (paperback)	29.95
Bright Star Atlas 2000	9.95
Edmund Mag 6 Star Atlas	18.95
Celestron Sky Map	16.95
Uranometria 2000 Volume 1 or Vol. 2	39.95
Deep-Sky Field Guide to Uranometria 2000	49.95

OBSERVERS' HANDBOOKS

The Backyard Astronomer's Guide	38.95
1000+: The Amateur Astronomer's Field Guide to Deep-Sky Observing	39.95
The Universe from Your Backyard	29.95

The Sky: A Users Guide	27.95
Nightwatch *by Dickinson*	24.95
Atlas of Deep-Sky Splendors, 4th Edition	36.95
The Messier Album	19.95
Observing Handbook and Catalogue of Deep-Sky Objects	49.95
Fifty Year Canon of Solar Eclipses: 1986-2035	24.95
Fifty Year Canon of Lunar Eclipses: 1986-2035	19.95
Burnham's Celestial Handbook 3 Vol. Set	38.95
Lunar Source Book: User's Guide to the Moon	49.95

Astrophotography & Imaging

A Manual of Celestial Photography	12.95
Astrophotography, 2nd Ed. *by Barry Gordon*	18.95
Astrophotography II	18.95
Astrophotography for the Amateur (Hard)	39.95
Choosing & Using a CCD Camera	29.95

ASTRONOMY SOFTWARE

Dance of the Planets
Standard Edition
114.95

New Dance of the planets QED with Observer Companion	**139.95**
Dance of the planets QED w/Observer Companion & Star 8 Extension	**169.95**
Star 10 Extension for Dance of the Planets	**54.95**

SKY FOR WINDOWS
Latest Version

The Sky Windows level 2	**Call**
The Sky Windows level 3	**Call**
LX-200 Interface	**59.00**
New Sky GSC (CD ROM)	**Call**
PC Sky	**74.95**

VIRTUAL REALITY

Mars Explorer (CD ROM)	**49.95**
Distant Suns (Disk)	**49.95**
Distant Suns (CD ROM)	**99.95**
Vista Pro (Disk)	**84.95**
Vista Pro (CD ROM)	**94.95**

TELESCOPE ACCESSORIES

DEW SHIELD

Collapsible, fold down easy to store and transport

for Celestron C90	**18.95**	for Meade 2045	**18.95**
f/8" Schmidt Cassegrains	**28.95**	f/10" Schmidt Cassegrains	**38.95**
f/5" Scopes	**24.95**	f/11" Scopes	**49.95**

Heavy Duty Rechargeable DC Power Pack

12 Amp Unit	**86.95**
DC Power Invertor Converts your AC Driver to 12Volt DC	**74.95**
Voltage and Frequency Converter Converts 110V to 220V	**89.95**

EYEPIECE FILTERS 2", 1¼" & .96"

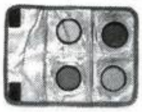
(Not all filters available in .96" & 2")

Avail. in the following colors: 1A Skylight; 8 Yellow ;11 Yellow Green; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 38A Blue; 47 Violet; 56 Light Green; 58 Green; 80A Light Blue; 82A Pale Blue; ND 0.3; ND 0.6

.96" & 1.25"	Ea. **11.95**	Polarizer 1 1/4	**13.95**
Moon Filter 1.25" (ND 9X)	**12.95**		
2" (Limited Availability)	Each **17.95**		
Buy any 4 filters (1.25")	for only **39.95**		
Buy any 12 filters	for only **109.95**		

Special: ***4 Piece Filter Set*** includes; #12, 23A, 58 & 80A Package in a filter pouch with room for additional filters for only **39.95**

Same as above with #11, 25A, 47 & 82A **39.95**



SOLAR FILTER *by Thousand Oaks Optical*

GLASS TYPE 2 Stainless Steel Coated MOUNTED

3.1"	**64.95**	**3.5"/4"**	**75.95**	**5"**	**95.95**
6"	**104.95**	**8"**	**114.95**	**10"**	**127.95**
11"	**149.95**				

New H-Alpha Solar prominence filter w/white light Pre Filter 8" .... **695.**

BINOCULARS

FUJINON FMT-SX Binoculars

6x30 FMTR-SX w/Rubber Coatings & fashion strap	**340.95**
7x50 FMT-SX with Carry Case & fashion strap	**372.95**
7x50 FMTR-SX w/Rubber Coating & fashion strap	**414.95**
7x50 FMTR-CSX R.C.with Compass & fashion strap	**472.95**
8x30 FMTR-SX Rubber Coated & fashion strap	**339.95**
10x70 FMT-SX with Carry Case & fashion strap	**470.95**
16x70 FMT-SX with Carry Case & fashion strap	**519.95**

10x70

New Fieldscope Super 80

Super 80 with 20X-60X	**689.95**
Super 80 ED with 20X-60X	**1069.95**

CELESTRON

GIANT

NEW MULTI-COATED

11x80 MC	**273.95**
New 12x80	**389.95**
15x80	**329.00**
20x80 MC	**329.00**
LPR filter set f/above.	**84.95**

ULTIMA SERIES

7x42	**Call**	8x32 w.a.	**Call**
7x50	**Call**	10x42w.a.	**Call**
10x50	**Call**	8x56	**Call**

PRO SERIES

7x50	**Call**	New 8x40	**Call**
9x63	**Call**	10x50w.a.	**Call**
12x50w.a.	**Call**	8-24x50	**Call**

ED GLASS SERIES

6.5x44	**395.**	9.5x44	**395.**

New MINI w/Rubi Coating

8x21	**65.**	9x25	**75.**

SWIFT

GIANT

Observer 11x80 BCF	**249.95**

SPOTTING SCOPES

Lynx 20x-65X	**199.95**

BINOCULAR ACCS.

Car Window Mount	**34.95**
Tripod Adapter	**16.95**

NIKON

10x70 SP w/case	**949.95**

SPOTTING SCOPES

15-45x60 Spotter R/C	**299.95**
15-45x Angle	**329.95**
20x Eyepiece	**46.95**
Photo Adapter f/SS	**49.95**

FIELDSCOPES (Body only)

Field Scope II	**239.95**
Field Scope ED II	**499.95**
Field Scope Angle	**299.95**
Field Scope Angle ED	**554.95**
New Field Scope ED 78mm	**899.95**
New F.S. ED 78mm Angle	**969.95**
15, 20, 30, 40X E.P.	@ **64.95**
60X **69.95** 30X WA	**126.95**
20-45X Zoom E.P.	**144.95**

ZEISS

W/O CASE

8x56 CF GA	**894.95**
15x60 CFT GA	**1434.95**
New 15x60 "B" for Eyeglass Wearers	**1699.95**

LEICA

7x42 GEOVID	**3699.95**

KOWA

SPOTTING SCOPES
w/20-60x zoom

TSN-1	**569.95**	TSN-2	**549.95**
TSN-3	**974.95**	TSN-4	**949.95**

without Eypieces

TSN-1	**375.00**	TSN-2	**359.00**
TSN-3	**799.00**	TSN-4	**779.00**

New NIGHT VISION Scopes & Binoculars

with these Night Vision aids you can see up to 200 feet in complete darkness

TEC-2 Owl Night Vision Scope 2.3X	**399.95**
Falcon Night Vision Binoculars 2.5X	**599.95**
Eagle Night Vision Scope 2.3X Camera Compatible	**599.95**

Pro-Optic

Astronomical Accessories

Pro-Optic offers a unique combination of high quality with economical prices

Adorama Exclusive

Pro-Optic Plössl 1.25" Eyepieces

If you have always wanted to upgrade your eyepieces to the high quality Plössl design but put off by their high prices; Pro–Optic Plössl is the answer.

• Sharp detail • High contrast ghost free images • Wide 50° apparent field of view (43° on the 40mm Plössl) • 4 element optics, fully magnesium fluoride ant-reflection coating on each air to glass surface.• Lens edges are blackened to keep out reflected light • Accepts 1.25" filters.

25mm Plössl 1.25"	**41.95**	17mm Plössl 1.25"	**41.95**
10mm Plössl 1.25"	**41.95**	7.5mm Plössl 1.25"	**41.95**
40mm Plössl 1.25" (Field of View 43°)	only **64.95**		

BUY ONE EYEPIECE AND GET THE SECOND ONE (of equal value) AT HALF PRICE!

Pro Optic 500mm f/5.6 Maksutov Telephoto/Spotting Scope

With high-tech white finish

Carry Case
Nikon
Pro-Optic

Multi-coated to maxjmize contrast and sharpness and a built-in field flattener to reduce field curvature.
With its 500mm focal length, it is long enough for close-ups of far away objects but with the f/5.6 optics it is fast enough to be hand held, focuses as close as 5 feet.
With the addition of the 'SS500 Kit you can convert it to a 20X 90mm spotting scope.
The SS500 kit includes a 45° 1.25" Erect Image Diagonal and a 25mm 1.25" Plossl

Pro-Optic 500mm f/5.6 lens	**249.95**
Pro-Optic SS500 Kit (when purchased w/500/5.6)	**49.95**
350mm f/4 Converter for 500/5.6	**74.95**

Pro-Optic Slow Motion Control

With the Slow Motion control attached between your Lens/Spotting Scope and your photographic tripod, you can make accurate slow motion adjustments in altitude and Azimuth in addition the Pro-Optic SMC allows you to make major adjustment in elevation with a separate control knob.
The Slow Motion Control fits any tripod with 1/4-20 thread.

Pro-Optic Slow Motion Control **39⁹⁵**

Pro-Optic 45º Erect Image Diagonal

Provides an ideal 45° angle for erect image terrestrial viewing

Pro-Optic 45° Erect 1.25"	42.95
Pro-Optic 45° Erect Hybrid (1.25" to .96")	39.95
Pro-Optic 90° Star Diagonal 1.25"	34.95

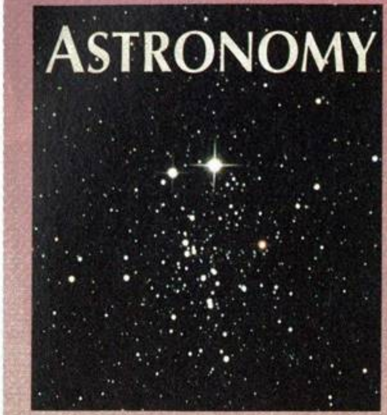
Attache Style

Pro-Optic

Deluxe Aluminum Eyepiece Case 14⅜ x 11⅜ x 5⅜"	**$49.95**
Deluxe Large Case 18" x 13" x6"	**$59.95**

SEE OPPOSITE PAGE FOR ORDERING INSTRUCTIONS

COMING IN THE FEBRUARY 1995 ISSUE OF



Lee Coombs

WINTER'S BRIGHT STAR CLUSTERS Visit seven bright but often overlooked clusters, such as the Owl Cluster (above), that dot the winter Milky Way in Perseus and Cassiopeia.

COMPELLING CAPELLA Recent studies reveal Auriga's brightest star consists of four stars — two yellow giants and two red dwarfs — that provide a preview of the Sun's distant future.

EXPLORE THE NEW VENUS Magellan's landmark four-year reconnaissance of our celestial neighbor reveals a dynamic geology remarkably different from that of Earth.

VIEWING THE SUN, SAFELY Tired of late-night observing sessions spent freezing under the stars? Then take a gander at sunspots, flares, granules, and more. Our star offers plenty to telescope owners who know how to observe it safely.

AVAILABLE ON YOUR NEWSSTAND

JANUARY 3

ASTRONOMY

Addtec Corporation	86
Adorama	106, 107
Advanced International Technology Inc.	86
Andromeda Software Inc.	100
Analytical Scientific	13
Argo	88
Astronomics	91
Astronomy Shoppe	102
AstroSystems, Inc.	88
Audobon Gallery	13
Ball Photo Supply	13, 102
Bennett Book Advertising	15
Berger Brothers	13, 102
Bethany Science	89
Dr. T. Biech	87
Bill Weaver Sporting Goods Inc.	13
Blue Sky Pages	102, 103
Bruce Johnston Computing	89
CC Sales/Camera Corner	13
Camera Bug	13, 102
Camera Shop In Bryn Mawr	13
Capellasoft	96
Celestron International	29, 114
Central Camera Co.	87
Ceravolo Optical Systems	19
Chimento Observation Supply	87
Claremont Camera & Video	12
Colonial Photo & Hobby	12
Computer Business Services	97
Coulter Optical Inc	101
Cutler Camera	13
Dallas Remote System	87
Dew Remover System	15
Dover Photo Supply	13
Eagle Optics	13, 103
Eagleton's	13
Earth Home	13
Earth & Sky Radio Series	92
Edmund Scientific Company	19
Efstonscience, Inc	13
Environmental Films	14
FC Meichsner Company	104
Focus Camera	52, 53
Franklin Mint	21
Gibeon Designs	87, 89
Robert A. Haag - Meteorites	86
Ed Hamilton, Bookseller	89
Harrison	103
Innovative Technologies	88
International Expeditions	87
International Network Enterprises	100
Iowa Scientific Optical	89
JMB Inc	86
JSL Perpetual Technology Inc	88
Jackson Camera & Video	13
Jim's Photo Shack Inc	12
Jim's Mobile Industries	65
Johnson's Camera	13
Jim Johnston	89
KC Woodsmith	89
Kalmbach Publishing Co	64, 94, 100, 104
Khan Scope Center	103
Killgore Southwest	88
Land Sea & Sky Unlimited	13
Learning Technologies Inc	88
Let's Talk Travel	88
Los Angeles Optical Co	95
Losmandy/Spectra Astro-Systems	19
Lumicon	44, 45
Main Sequence	86
Makewood Products	87
Marketplace, The	86, 87, 88, 89
Mazon Productions	101
Meade Dealer Pages	12, 13
Meade Instruments	2, 3, 7, 8, 9, 10, 11, 12, 13
Meadows Camera Shops	12
Mike's Camera Inc	12
Milford Camera Shop Inc	12
Mountain Skies Astronomical Society	89
Mr. Telescope	12
Murnaghan Instruments	98
Naturium	13
Natural Heritage Shop	103
New England Meteoritical	102
New Mexico Astronomical	87, 102
Newbridge Communications Inc	27
Newport Glass Works	88
Novagraphics	92
Christian Nuesch	88
Nurnberg Scientific	102
Oasis Group Productions	89
Oceanside Photo & Telescope	12
Orion Telescope Center	36, 37
Outer Edge Expeditions	86
Palomar Optical Supply	88
Parks Optical	97
Pegasus Classifieds	88
Perceptor	13
Pete's Photo World	13
Phils Camera	12
Photo Researcher	89
Photo Supply Inc	13
Pocono Mountain Optics	18, 93, 101, 103
Precision Optics	25
Quadrant Systems	18
Rainbow Symphony, Inc	101
Reader's Exchange	100, 101
Redlich Binocular & Optical	13
Rex's Astrostuff	89
Riders Hobby Shops	12
Ritz Camera Superstores	13
Rivers Camera Shop	12, 102
Royal Astronomical Society of Canada	14
SDB Systems	86
Sarasota Camera Exchange Inc	12, 102
Science Connection, Inc	87
Sedona Telescope Center	12
Shutan Camera & Video	105
Siber Optics	96
Sirius Instruments Company	16
Sky Bear Publishing	86
Smithsonian Institution Press	95
Software Bisque	17
Software Systems Company	97
Southern Cross Tours	86
Spectra Astro-Systems/ S.B.I.G.	15
Star Gazer Instruments	103
Star Hill Inn	98
Stargazer Steve	92
The Starry Messenger	87
The Starry Messenger Press	89
Starsplitter Telescopes	88
Stellar Products	16
Stellar Vision	12, 102
James Stewart	86
Tech 2000	86
Technical Innovations	95
Tekton Industries	89
Tele Vue Optics, Inc	113
Thousand Oaks Optical	98
Tracy-Adams Photo Supplies Inc	13
Tranquest	86
Tuthill, Roger W. Inc	13, 91, 98
What A World	12
What In The World	12
Wholesale Optics (Pauli's)	99
Wm. C. Brown Publishers	94
Wilderness Travel	87
Wonder Works	103
Yost & David	89
Zeiss Group, Astronomical Inst.	23
Zephyr Services	90

Comets, We've Got Comets. . .

While Comet Shoemaker-Levy 9 dominated last year's observational headlines, a dozen comets lucky enough to have survived their journey near the Sun gave backyard astronomers plenty to view. Here's a sampling of reader reaction to the better comets visible over the last fourteen months.

Comet Mueller (1993a). Perihelion date: January 12, 1994. Peak brightness: magnitude 9.1 (November 5, 1993). "The comet appears brighter on its eastern side and is showing a fan-like glow on its western side." — *Matthew Boulton, Redditch, Worcestershire, England, observing with a 10-inch reflector at 65x and 130x on October 21, 1993.*

Comet P/Schwassman-Wachmann 2. Peri. date: January 23, 1994. Peak brightness: 11.3 (January 21). "The comet appeared about 10' away from the galaxy NGC 2545, forming an odd pair. The galaxy had a bright center but its outer arms had about the same brightness as the comet." — *Richard R. Didick, Rehoboth, Massachusetts, observing with an 8-inch f/8 reflector at 46x on March 5, 1994.*

Comet Mueller (1993p). Peri. date: March 26, 1994. Peak brightness: 8.4 (April 18). "The comet appeared to be glowing evenly across its face with a small, round central condensation measuring about 1' across." — *Richard R. Didick, observing with an 8-inch f/8 reflector at 130x on October 14, 1993.*

Comet McNaught-Russell (1993v). Peri. date: March 31,

Comet Takamizawa-Levy (1994f)

by Keith Snyder, Steve Messner, Bob Elliott, and Paul Nelson (12-inch reflector, STAR-I CCD camera, 160-second exposure in July 1994)

Comet Nakamura-Nishimura-Machholz (1994m)

by William McLaughlin and Dennis Luse (8-inch SCT at f/6, ST-5 CCD camera, 60-second exposure on August 12, 1994)

Comet McNaught-Russell (1993v)

by Keith Snyder, Steve Messner, Bob Elliott, and Paul Nelson (12-inch reflector, STAR-I CCD camera, 160-second exposure in July 1994)

1994. Peak brightness: 7.9 (May 8). "It was a softly glowing fuzzball with no discernible tail." *—Eric B. Vondra, Bellevue, Pennsylvania, observing with a 4.5-inch reflector at 100x on April 8, 1994.*

Comet Takamizawa-Levy (1994f). Peri. date: May 23, 1994. Peak brightness: 8.8 (May 22). "A blob with a hint of a tail." *— Carl Weber, Lemon Grove, California, observing with 20x80 binoculars on June 19, 1994.*

Comet P/Tempel 1 (1993c). Peri. date: July 3, 1994. Peak brightness: 9.2 (May 31). "The comet has a beautiful fan-shaped coma that appears brightest along the southern edge." *— Richard R. Didick, observing with an 8-inch f/8 reflector on May 11, 1994.*

Comet Nakamura-Nishimura-Machholz (1994m). Peri. date: July 13, 1994. Peak brightness: 7.5 (August 27). "I estimate its total brightness at magnitude 8.6." *— Christopher E. Spratt, Victoria, British Columbia, observing with an 8-inch SCT on July 31, 1994.*

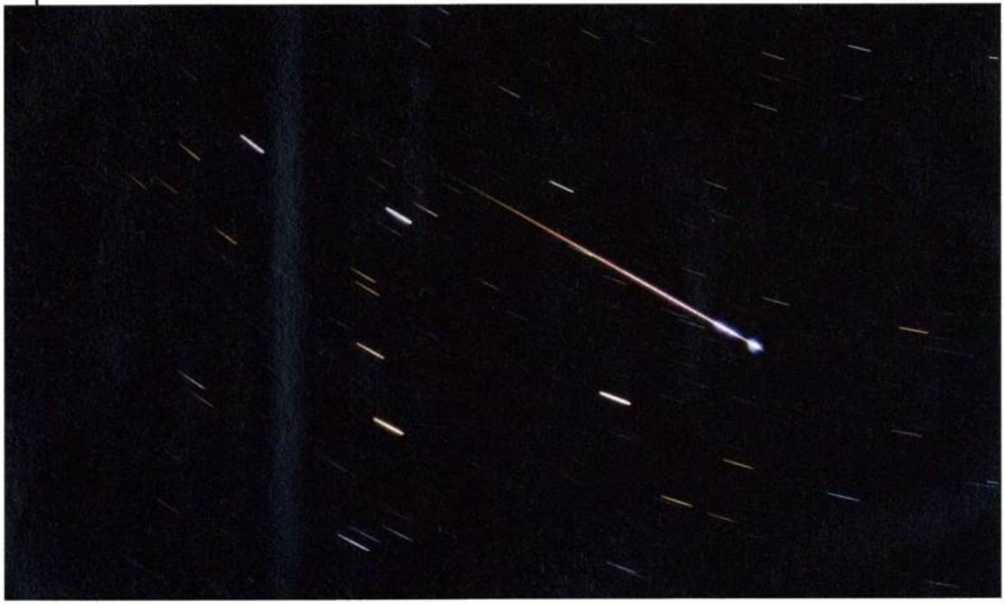
Comet P/Machholz 2 (1994o). Peri. date: Sept. 19, 1994. Peak brightness: 6.8 (Sept. 5). Soon after its discovery, astronomers began spotting fragments near this comet traveling with the same motion.

"I could see two of the comet's five pieces. The primary body was a typical 7th-magnitude comet, appearing 4' across with a slight central condensation." *— Tom Polakis, Tempe, Arizona, observing with an 8-inch f/3.8 RFT at 85x on September 14, 1994.* □

ASTRONOMY wants to hear about your observations of the sky. Send reports, sketches, and photographs to David J. Eicher, Reader Reports Editor, ASTRONOMY, P.O. Box 1612, Waukesha, WI 53187. Please label each photo with name, address, and social security number. You may send written reports via the Internet to: 72000.2704@CompuServe. com

The North America Nebula

by Sam Bissette
(50mm lens; inset is a 50x enlargement photographed through a microscope)

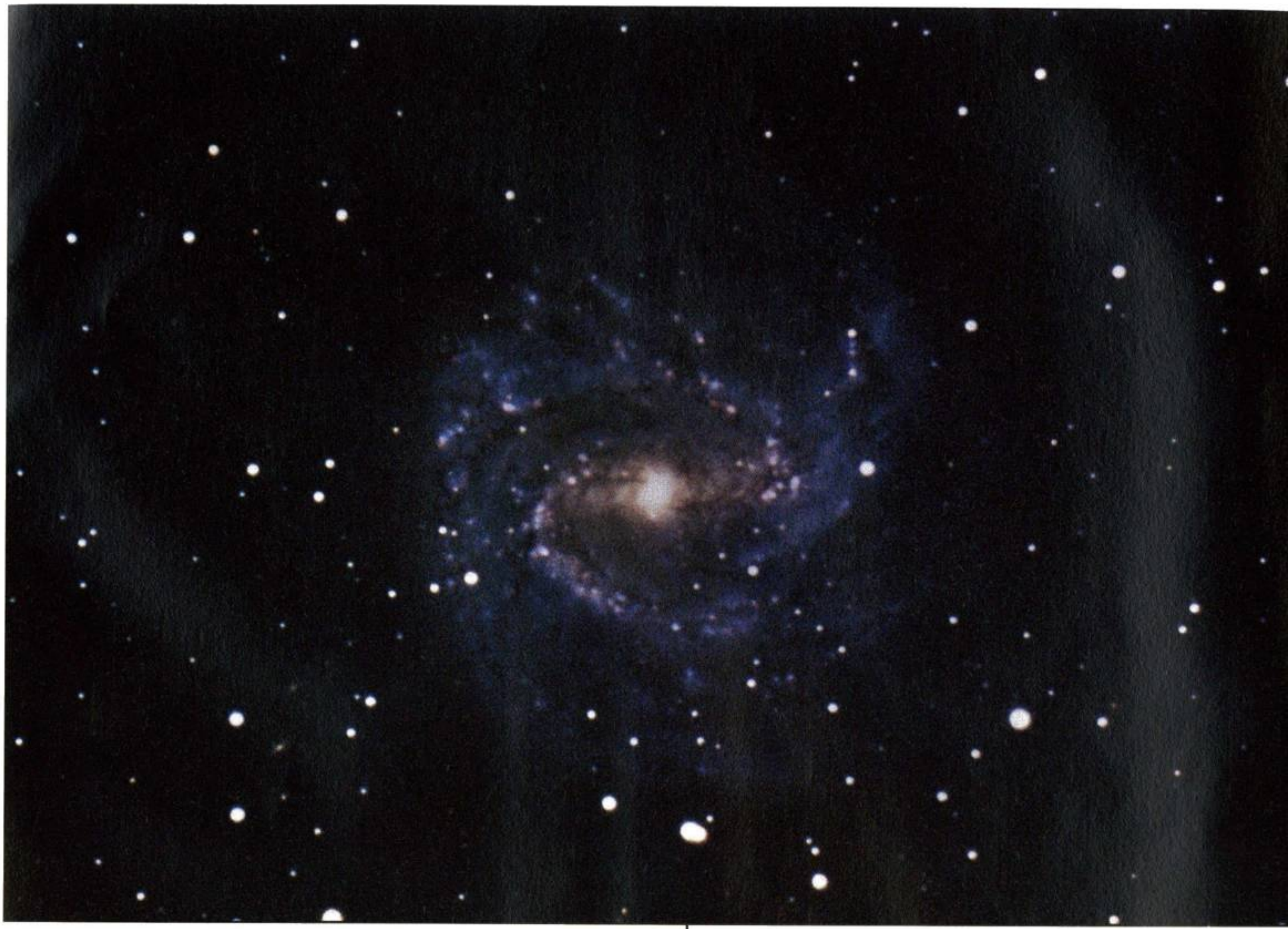


A Bright Perseid Flashes Overhead

by John Blankenship
(40mm lens at f/4, 8-minute exposure taken on August 12, 1994)

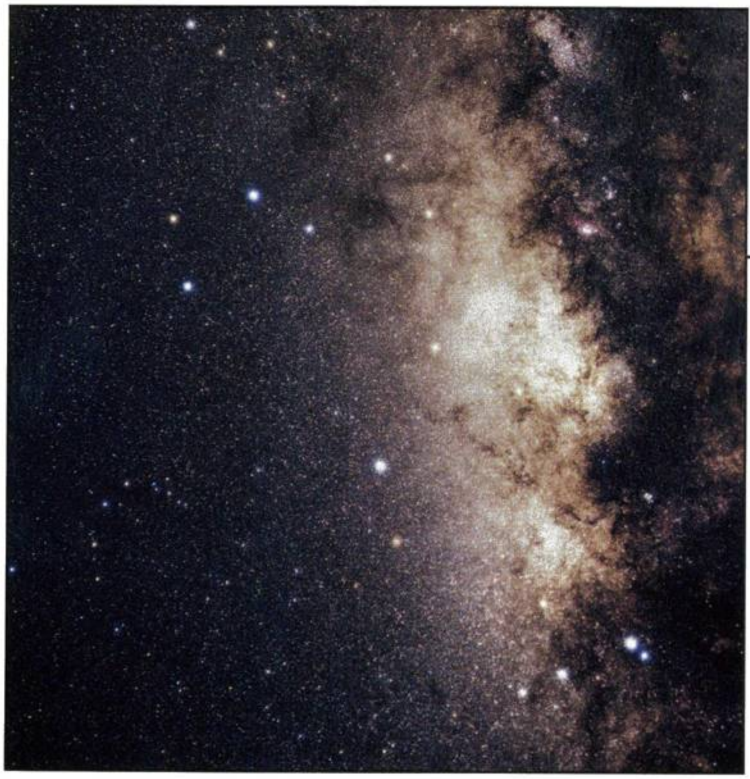
The Draco Dwarf Galaxy

by Kim Zussman
(14.5-inch f/8 Cassegrain, hypersensitized Tech Pan film, 190-minute exposure)



Galaxy M83 in Hydra

by George Greaney and Mike Newton
(14-inch SCT at f/7, hypersensitized Fuji Super HG 400 film, composite of two 55-minute exposures printed onto Vericolor print film)

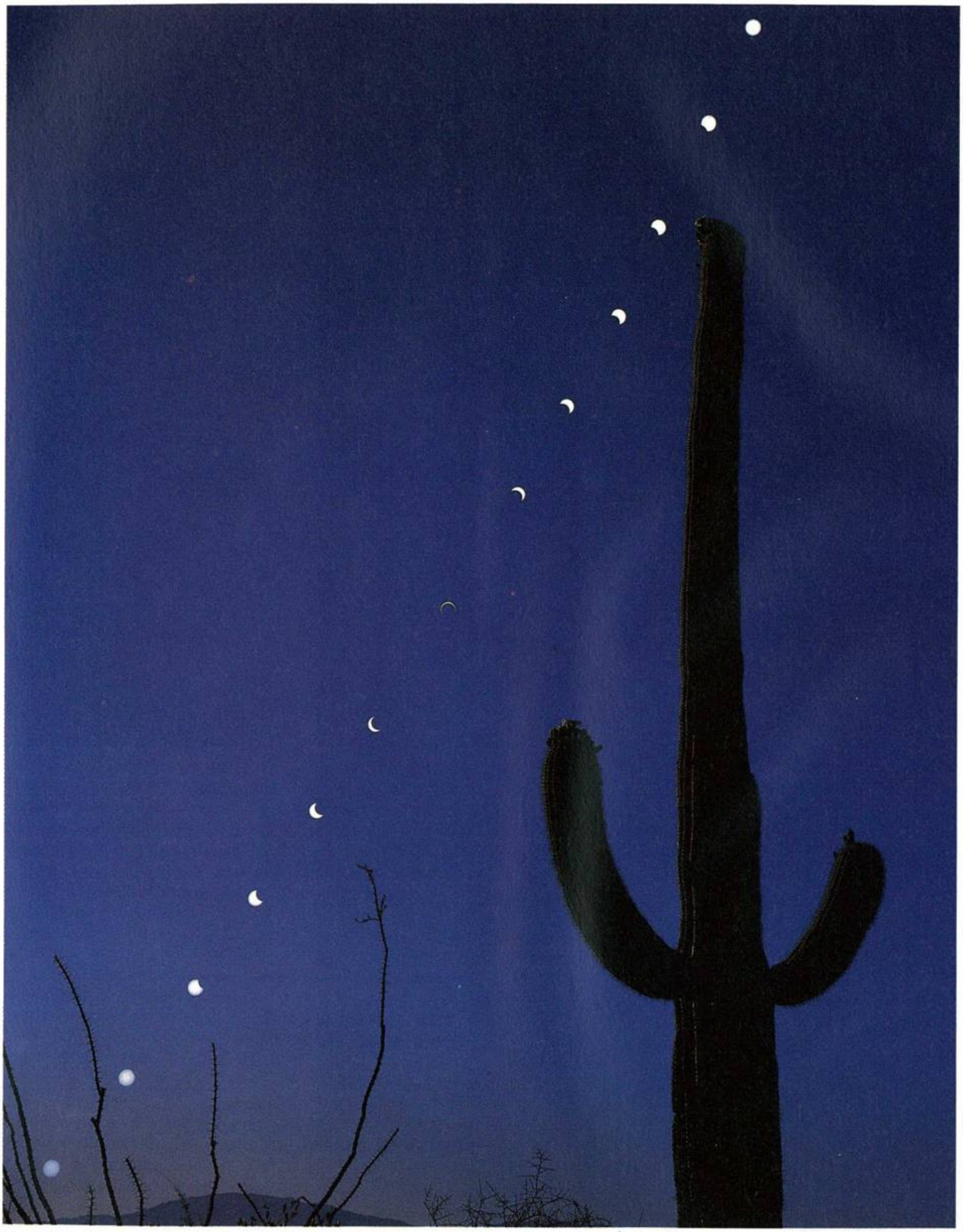


The Star Clouds of Sagittarius

by Luke Dodd
(105mm lens at f/3, hypersensitized Fujicolor 400 film, composite of two 20-minute exposures)

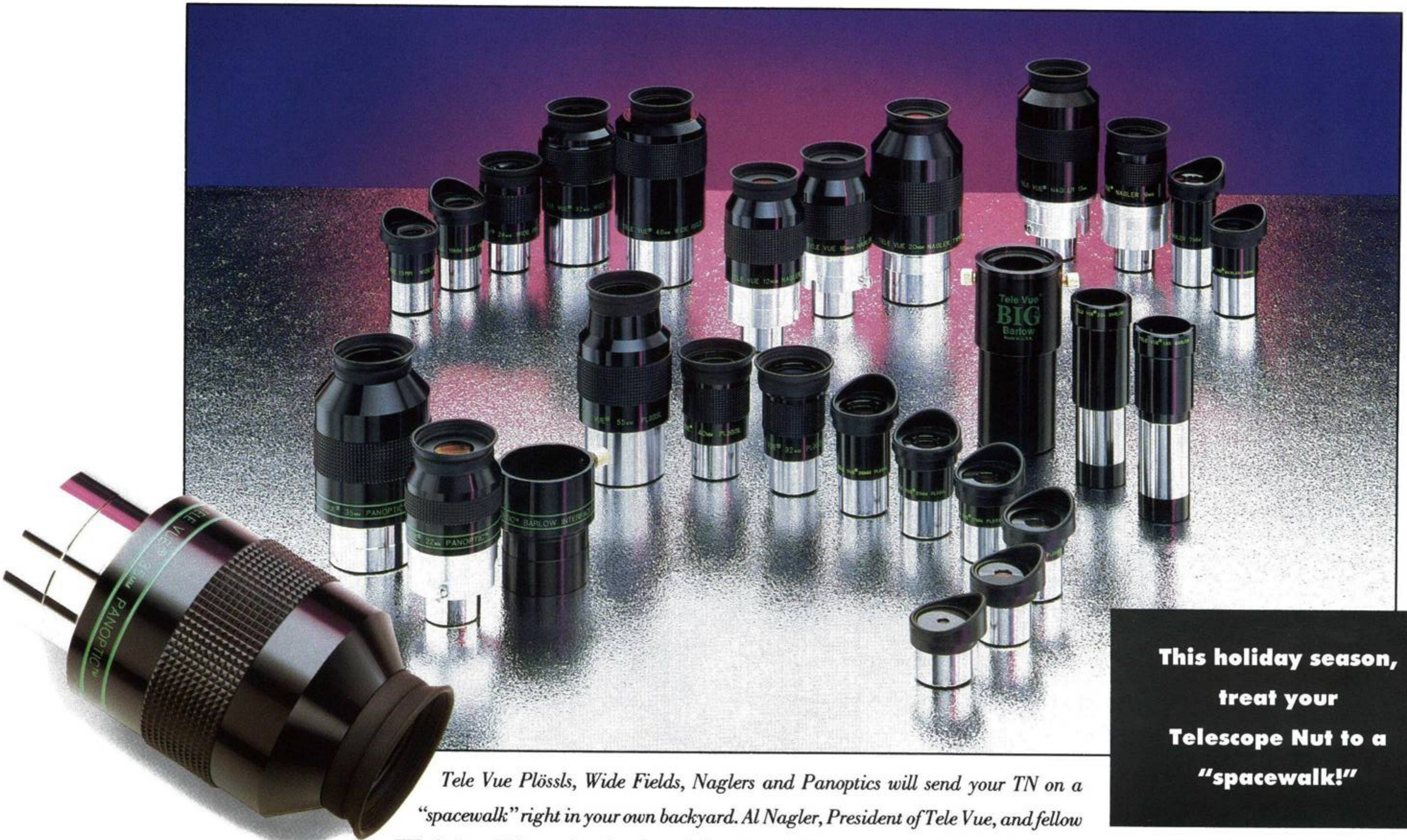
Ultimate Exposure

Wins $100 as ASTRONOMY's Best Astrophoto



Solar Eclipse Over Arizona

by Kent Wood
(150mm lens at f/22, composite image of thirteen 1/4-second exposures at 15-minute intervals on May 10, 1994, taken from Tucson, Arizona; foreground photo was a 1/15-second exposure at f/32)



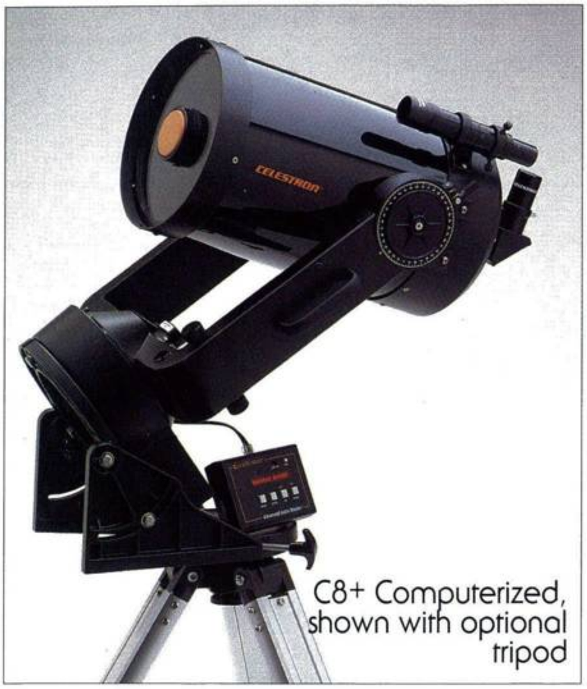
This holiday season,
treat your
Telescope Nut to a
"spacewalk!"

Tele Vue Plössls, Wide Fields, Naglers and Panoptics will send your TN on a "spacewalk" right in your own backyard. Al Nagler, President of Tele Vue, and fellow TN, designed his eyepiece family to deliver sharper, larger apparent fields with more contrast and less lateral color for any telescope; refractor, reflector, fast or slow. Tele Vue is the only manufacturer to ensure your TN's holiday joy with a multi-point quality control inspection of every eyepiece. And the value of fine quality Tele Vue eyepieces will be appreciated for many holiday seasons to come. So remember, Tele Vue eyepieces bring the biggest holiday hugs! From our family to yours, we wish you clear skies always.

Tele Vue®

Eyepiece literature free; for full-line literature please include $3 for postage and handling
Tele Vue Optics, Dept A, 100 Route 59, Suffern, NY 10901. (914) 357-9522.

CELESTRON® C8 *Winter Bonus*



C8+ Computerized, shown with optional tripod

Ultima® 8

C8+ Telescope — For astronomy on the go, you can't beat the C8+. Runs off a single 9 volt battery for up to 50 hours. No need to be near your car or carry other 12 volt systems with cords all over the place. A hand controller is included as well as a built-in drive corrector. Starbright® coatings are standard. Optical crown glass for the corrector and a properly baffled system ensure the finest optical quality in a Schmidt-Cassegrain system. Standard accessories include: 6X30 finderscope, star diagonal – 1¼" 25mm Kellner eyepiece – 1¼" and wedge.

C8+ Computerized — Is the same as the C8+ with the addition of a **factory installed** and **tested** Advanced Astro Master® to give you a computerized telescope. Once aligned, this unique accessory will guide you to any of the more than 10,000 objects in the data base.

ADD THE OPTIONAL ADVANCED ASTRO MASTER® TO COMPUTER CONTROL THE C8+ OR ULTIMA®8

Ultima® 8 — For the more serious observer and astrophotographer who seeks the finest Schmidt-Cassegrain optics along with the utmost in rigidity and the most accurate drive system. As with the C8+, the Ultima®8 runs off a single 9 volt battery. Standard accessories include: a hand controller, 7x50 finderscope, 26mm Plössl eyepiece – 1¼", star diagonal – 1¼", wedge, tripod and rugged foam fitted carrying **case**.

FREE CELESTRON ACCESSORIES

Purchase any of the three telescope models in this ad between December 1, 1994 and February 28, 1995 and receive **free**:

- **With the C8+** — Reducer/Corrector f/6.3
  FREE VALUE — $190
- **With the C8+ Computerized** — Reducer/Corrector f/6.3 and Solar Filter
  FREE VALUE — $360
- **With the Ultima® 8** — Dec. motor and Focus motor
  FREE VALUE — $420

*To receive your **free** accessories in the U.S.A., send proof of purchase to the Celestron Customer Service Department. Outside the U.S.A. contact your Celestron dealer or distributor.*

For more detailed information on these telescopes, contact your Celestron dealer or Celestron.

CELESTRON® LIGHT YEARS AHEAD OF THE COMPETITION

Celestron International • 2835 Columbia St., Torrance, CA 90503 • 310-328-9560 • FAX 310-212-5835